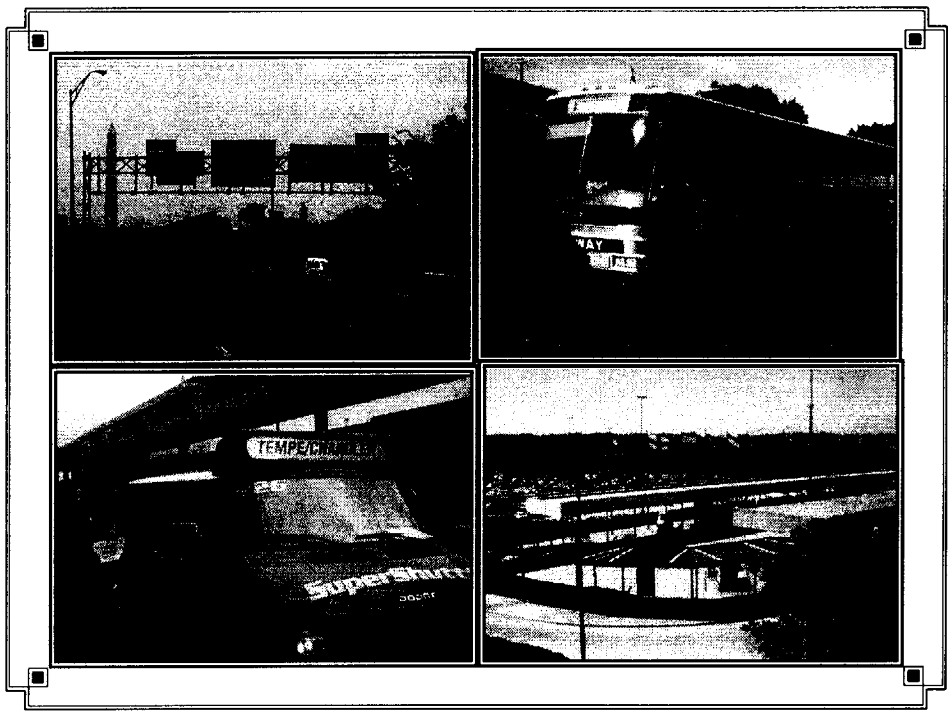
INTERMODAL GROUND ACCESS TO AIRPORTS: A PLANNING GUIDE

Prepared For:

Federal Highway Administration

&

Federal Aviation Administration



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This guide is designed for use by airport, State, local, and metropolitan planners to manage and plan for intermodal ground access for all types of airports. It identifies key components of an airport access work program and contains detailed sections on airport groundside access planning methods, including data collection methods and analysis, identification of current travel patterns and emerging trends, forecasting techniques, estimating modal split, evaluation of alternatives, and implementation.

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CHAPTER 1

INTRODUCTION

Access to airports has been discussed as a growing transportation problem in the United States since the early 1970s.[1] As air travel, urban congestion, and environmental concerns have significantly increased over the last quarter century, multimodal access to airports has become an even greater concern. U.S. Department of Transportation (U.S. DOT) guidance for airport access planning has been limited.[2 3] The increasing need to plan for intermodal facilities and growing airport access problems led to the development of this planning guide, *Intermodal Ground Access to Airports*, for the Federal Highway Administration (FHWA) and Federal Aviation Administration (FAA).

This guide is designed to provide policy guidance, rules of thumb, data, and analytical techniques related to airport access. It has been prepared to help airport operators, local governments, metropolitan planning organizations (MPOs), consultants, and others identify airport access problems, find alternative solutions, and evaluate their effectiveness. Primarily, this guide compiles information from other sources; however, it summarizes and presents this information so that it can be used to systematically analyze airport access problems and alternative solutions.

The guide focuses on providing passengers access to commercial airports from primary origins or destinations. It deals with:

- Off-airport roads, transit, and high-occupancy vehicle (HOV) facilities up to the airport boundary

- On-airport roads, parking circulation elements, transit, and curb facilities up to the terminal entrance.

1.1 Importance of Airport Access

As shown in figure 1.1-1, total annual passenger enplanements in the United States, including commercial, international, and commuter passengers, is projected to grow by over 400 million between 1995 and 2005.[4] This 50-percent growth in total enplanements will generate significant problems for groundside facilities at many U.S. airports. Some components of passenger traffic will grow even faster than the average; enplanements on international flights will grow by over 75 percent and nearly double on regional commuter flights during this 10-year period. This growth in demand for air travel will generate increased problems for groundside facilities at commercial airports, particularly airport access facilities.

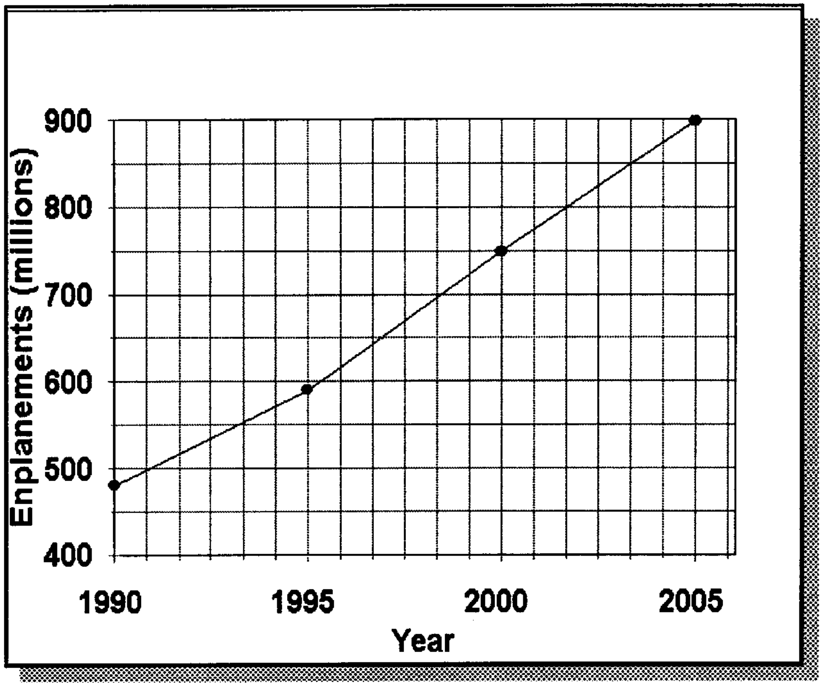

Figure 1.1-1. Total Scheduled Passenger Enplanements at U.S. Commercial Airports

Historically, most passengers have used private automobiles to gain access to airports, and this will continue to be the primary mode of access in the future. However, as passenger demands increase, multimodal alternatives will become increasingly important to the efficient use of access facilities in and around U.S. airports. Enplanements at small- and medium-hub airports, where a large percentage of regional commuter service is provided, will increase at a faster than average rate. Even these airports, which have had very little multimodal access in the past, will probably need to increase access options for passengers using their facilities in the future.

In 1994, nearly 100 operators of small-, medium-, and large-hub airports were surveyed by the Airport Council International-North America (ACI-NA) regarding the importance of airport access issues affecting their airports.[5] Operators were asked to rate airport access issues on a scale of 1 (no problem) to 5 (significant concern). Three of the identified areas of concern were:

- Off-airport access roadway congestion
- On-airport roadway congestion
- Curbside congestion.

The results of this survey are shown in table 1.1-1. At least a third of all surveyed airports rated all three areas with a 4 or 5. At least 45 percent of large- and medium-hub operators expressed concern for on- and off-airport roadway congestion. Operators of over 75 percent of these larger airports and nearly 50 percent of small-hub operators expressed concern over curbside congestion.

Air travel is composed of a combination of time in the air, time at the airport, and time on the ground spent getting to and from a location. Both travelers and operators are acutely aware that time spent on the ground is quickly increasing. Nearly 75 percent of airport operators surveyed by ACI-NA indicated that passengers experience more delay on access and circulation roads than they do on the airfield. The growth potential of airport facilities will be limited as access to airports becomes more difficult and time-consuming. Some researchers predict that as air travel increases, so too will the number of multiple-airport hubs.[6] Airports in neighboring metropolitan areas are also competing with each other, as has been experienced among the three airports in the Baltimore and Washington metropolitan areas for over a decade. As air travel times from competing airports become more and more comparable, accessibility to the airport will become more of a determining factor in travelers' airport preferences.

Table 1.1-1. 1994 ACI-NA Survey of Airport Surface Access Critical Issues and Concerns

	No Problem				Significant Concern
Issue	**1**	**2**	**3**	**4**	**5**
Off-Airport Access Roadway Congestion	17%	25%	21%	15%	21%
On-Airport Roadway Congestion	18%	28%	22%	19%	14%
Curbside Congestion	5%	12%	22%	30%	31%

Clearly, airport operators are concerned about airport access congestion, and with the projected increase of enplanements over the next 10 years, these concerns will probably grow. The preference by passengers for automobile-based airport access and the increased demands for facilities to accommodate those automobiles will continue to put pressure on access facilities.

To remain competitive, airport authorities and government agencies responsible for providing ground transportation access facilities will need to improve the way that automobiles are accommodated at airports and increase the availability of comparable high-occupancy-mode alternatives that decrease reliance on the private automobile.

1.2 Intended Users

Construction of few conventional "new" airports is anticipated in the next decade, particularly in metropolitan areas of the United States. Consequently, increases in air and landside activities—brought on by such factors as ever-increasing air traffic, new airlines, and larger aircraft—will mean many existing airports will have to undergo expansion. The airport owner/operators and government agencies responsible for planning and providing transportation facilities will be directly involved in planning for improved access to existing airports and providing new access facilities to the few new airports that are built. These operators, planners, and engineers will need guidance on how to better plan for airport access needs. This document begins to provide guidance for studying airport access problems and identifying and implementing alternative multimodal solutions.

Off-airport and some on-airport access plans and programs must frequently be coordinated with other regional transportation plans and programs and must be consistent with regional and State plans and programs, such as long-range transportation plans and regional and State air quality plans. To successfully compete for Federal funding, airport access plans and programs sometimes require the approval of regional or Federal agencies. Airport planners must have a basic understanding of the federally mandated transportation planning and programming process to successfully integrate their access plans with other transportation plans and programs and compete for Federal funding of airport access improvements.

The FAA has been involved in airport access planning for a long time. Other Federal agencies are becoming more involved, as intermodal transportation planning and compliance with environmental laws are further emphasized. Airport access improvements, particularly off-airport, also require funding and approval by Federal agencies. Federal agencies involved in the planning and funding of airport access facilities and their respective roles are described in table 1.2-1. State, regional and local planning organizations, such as State transportation agencies, MPOs, and local agencies, are becoming more involved in airport access planning and funding. The respective roles of these agencies are described in table 1.2-2. These planning organizations are often unfamiliar with the differences between the access needs of airports and the transportation needs of other land uses. These regional planning organizations need guidance and data to help them better understand how to accommodate airport access needs in regional planning and funding processes. They also need guidance regarding analysis techniques, rules of thumb, and other data that are useful for planning airport access needs.

Sometimes, other organizations, such as financing entities, airlines, and consultants, also become involved in planning, designing, or implementing airport access improvements. Often, however, they have limited knowledge of airport access planning, its importance, and how it relates to their areas of interest. Some of these organizations are identified in table 1.2-3. This guide serves as a reference for these organizations, providing data and other information that will give them a better understanding of the process.

Table 1.2-1. Federal Agencies' Roles in Airport Ground Access Planning

Organization	Role
Federal Aviation Administration (FAA)	- Directs Federal-aid airport program and other funding sources. - Provides advisory services and is responsible for certification of airports serving air carriers.
Federal Highway Administration (FHWA)	- Develops and recommends policies relating to roadway planning and design, transportation planning, traffic engineering, and intermodal activities. - Funds highway-related improvements.
Federal Transit Administration (FTA)	- Develops and recommends policies relating to transit planning and design, transportation planning, and intermodal activities. - Funds transit-related improvements.
Federal Railroad Administration (FRA)	- Develops and recommends policies relating to railroad planning and design, transportation planning, and intermodal activities. - Funds sources related to commuter rail.
Environmental Protection Agency (EPA)	- Sponsors environmental review of projects and monitors compliance with environmental laws, such as the Clean Air Act Amendments.

Table 1.2-2. State and Local Agencies' Roles in Airport Ground Access Planning

Organization	Role
State DOTs	- Distribute Federal funds. - Provide State aid to local airport authorities. - Plan State airport systems. - Design, construct, and maintain highways and, in some cases, transit systems that provide ground access to airports.
MPOs	- Develop regional transportation plans and coordinate efforts of municipalities (counties, cities, towns).

Municipalities and Local Jurisdictions	- Plan, design, construct, and maintain transportation facilities and services outside airport boundaries.

Table 1.2-3. Private Organizations' Roles in Airport Ground Access Planning

Organization	Role
Financing Entities	- Investment banking firms, underwriters, bonding counsel, rating agencies (i.e., for revenue bonds), banks, and other private companies often provide financing for airport facilities to supplement Federal grants (e.g., the Airport Improvement Program [AIP]), passenger facility charges (PFC), landing fees, leasing and concession income, general tax revenues, State funds, and local funding.
Public and Private Transit Operators	- Provide vans, limousines, taxis, paratransit, and other high-occupancy access to airports.
Planners, Architects, Engineers, and Consultants	- Plan and design airport groundside facilities.
Airlines, Concessionaires, and Lessees	- Car rental companies and parking operators.
Associations	- Airport Council International - North America (ACI-NA) - American Association of Airport Executives (AAAE) - International Air Transport Association
Miscellaneous	- Regulators, attorneys, consumer advocates, economists, and researchers.

1.3 Organization of the *Ground Access Planning Guide*

Figure 1.3-1 outlines a technical approach to airport ground access planning and provides a framework for this planning guide. Chapter 2 describes airport access problems, the roles of State and local agencies, and the relationship between airport access and the Clean Air Act. Chapter 3 discusses the development of performance measures and their relationship to goals and objectives. Chapter 4 details the types of data that may be collected to quantify performance measures and determine access patterns and demand. It also describes techniques for obtaining needed data and provides specific guidance for conducting passenger origin-destination surveys.

Chapter 5 provides an overview of how to estimate existing and future airport access patterns and demands and how to identify potential deficiencies. Chapter 6 describes alternative access improvements, including HOV options, intermodal facilities, and improvements to airport infrastructure, such as access roads, parking facilities, and terminal curbside. Chapter 7 describes how to evaluate alternative improvements, and Chapter 8, how to implement them.

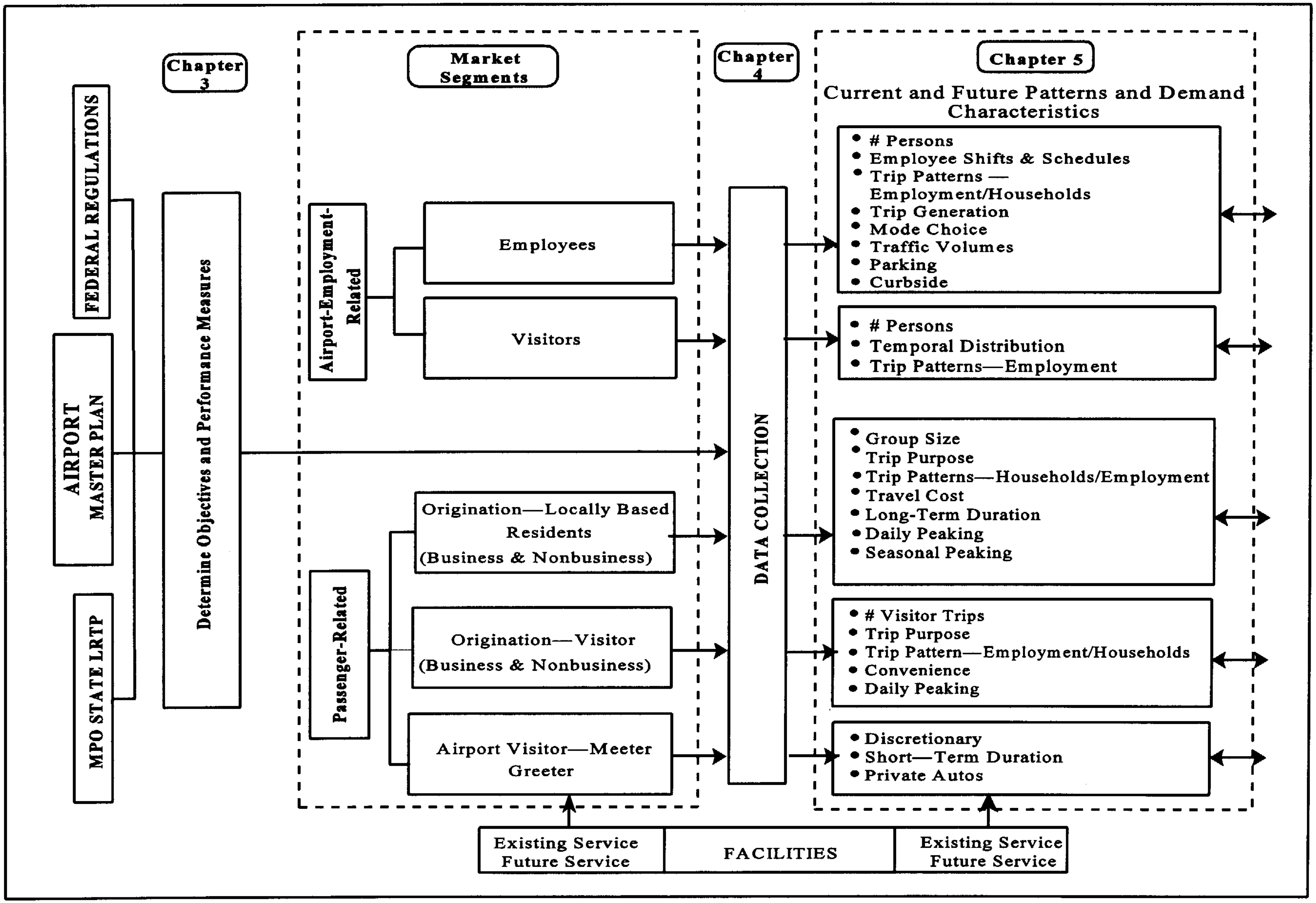

Figure 1.3-1. Technical Approach to Airport Access Planning

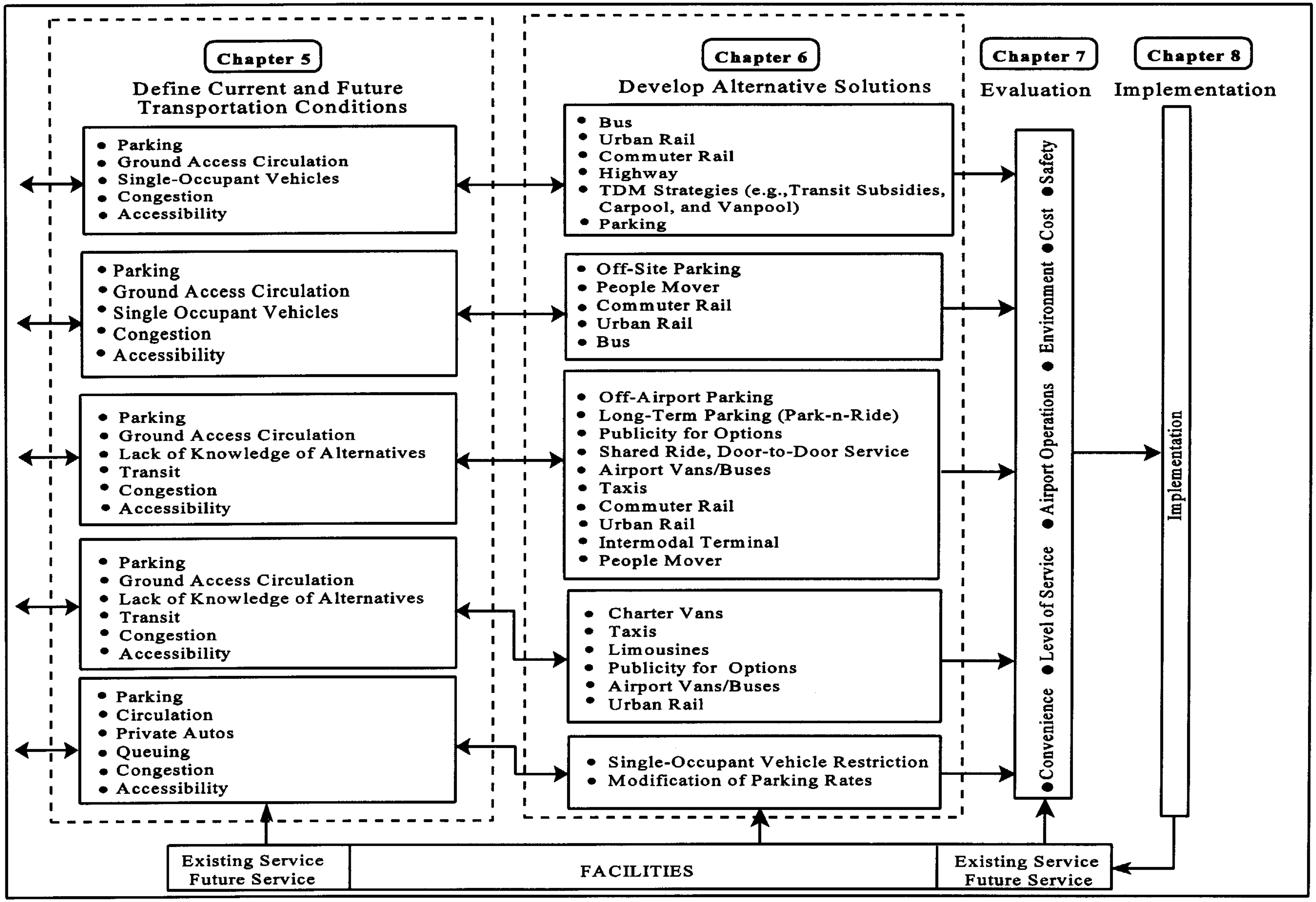

Figure 1.3-1. Technical Approach to Airport Access Planning (continued)

1. U.S. DOT. "Access Issues (p. 4)." *Airport Access, A Report of the Transportation Task Force of the Urban Consortium for Technology Initiatives*. Washington, DC: U.S. DOT, 1980.

2. FAA. *Airport Ground Access and Circulation Systems,* Publication AC 150/5360-13 CHG1, ch 9. Washington, DC: FAA, 1994.

3. Whitlock, Edward M. and David B. Sanders. *Airport Access/Egress System Study,* Vol. 1. Washington, DC: U.S. DOT, 1973.

4. DOT, FAA. *National Aviation Activity Forecasts: Fiscal Years 1995 - 2006*, Publication PPIX12. Washington, DC: U.S. DOT, 1995.

5. Airport Council International. *North America Unpublished Survey Results,* April 1994.

6. Hansen, Mark and Tara Weidner, *Multiple Airport Systems in the United States: Current Status and Future Prospects,* Publication TRR 1506, pp. 8-17. Washington, DC: Transportation Research Board (TRB), 1995.

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CHAPTER 2

OVERVIEW OF THE AIRPORT GROUND ACCESS PLANNING PROCESS

In this chapter, several major planning issues related to airport ground access improvements will be examined. Some of these concerns are driven by problems central to airport managers and operators themselves, such as the need to expand airport capacity, provide accessibility and support economic development in key areas, and minimize environmental damage to neighboring communities. Other problems are of primary concern to those responsible for transportation planning at both the State and metropolitan levels. Still other issues are driven by the existence of various Federal laws and regulations. This chapter will review these considerations that originate at the facility, metropolitan, State, and Federal levels.

This chapter contains two sections. First, a quick overview of the proposed airport ground access planning process is presented. This overview establishes a seven-step planning process, each step relating to succeeding chapters in this guide. The second section, Problem Definition and Policy Context, summarizes the factors and concerns that are key to undertaking the first step in the ground access planning process. This section of Chapter 2 includes a review of various legal, regulatory, and institutional considerations in the initial development of a work plan for an airport ground access planning process.

2.1 The Airport Ground Access Planning Process

The planning process in this guide has been designed to encourage development of site-specific analyses to be carried out by local and MPO planners in a manner consistent with the planning process required for statewide and system-wide management systems. The planning process has been designed to maximize consistency between the airport-based planning process and State and metropolitan area responsibilities for the preparation of the congestion management system (CMS) and the intermodal management system (IMS). The chapters of this guide have been organized to reflect the planning process steps of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), as applied to the development of airport ground access strategies and projects. The seven step process is described in table 2.1-1.

The seven steps of the process can be summarized as follows:

1. Define the problem. What policy issue is being addressed?

2. Given the understanding of the policy issue, establish performance measures to be used in the program of monitoring and evaluation.

Table 2.1-1. Seven-Step Airport Ground Access Planning Process

Step	Basis in Regulations	Purpose	Examples in Airport Access
One: **Define problem and policy context.**	"The IMS shall identify intermodal facilities and intermodal transportation systems and establish the demands placed upon them to accommodate intrastate, interstate, and/or international movements of people and goods."	Careful determination of central policy issues faced by the airport, its unique characteristics, and setting define what kinds of "performance" it is important to monitor.	An airport in a nonattainment area must lower total vehicle miles of travel (VMT) associated with airport access. Isolation of a rural airport without adequate connection to the region's controlled access highway system.
Two: **Define performance measures.**	"Parameters shall be identified that are suitable to measure and evaluate the efficiency of intermodal facilities and systems in moving people and goods from origin to destination. Parameters may include total travel time, cost and volumes for moving cargo and passengers, origins and destinations, capacity, accidents, ease of access, perceived quality and the average time to transfer people or freight from one mode to another."	Early establishment of "the rules of the game" (i.e., the measures that will be used in determining the success or failure of the system performance). However, the selection of measures is undertaken only after agreement on the nature of the challenges faced in and around the subject airport is reached.	Quality of traffic flow on the access roads near and at the airport. Amount of choice offered to arriving passengers. Is there adequate taxi, shared-ride van, and scheduled bus service? Percentage of region served by shared-ride services? Percentage of passengers who arrive by other than private vehicles or single-ride taxis? Percentage of passengers who arrive in vehicles with low emission propulsion?
Three: **Collect data needed to apply performance measures.**	"The IMS shall include a continuing data collection and system monitoring program. It shall include a base year inventory consisting of physical and operational characteristics of intermodal facilities and systems, and surveys of the operational and physical characteristics of intermodal facilities and systems based on performance measures established by State and local transportation agencies."	Data collection efforts should document both asset condition and level of performance. Airport access patterns are usually understood by examining a variety of data sources, including periodic ground access surveys, ridership and revenue data, and regional trip tables based on a simulation process. Operational characteristics may include time, cost capacity, and usage.	Port Authority of New York and New Jersey program monitoring ground access patterns to JFK, LaGuardia, and Newark airports in continuous operation for several decades. Valuable time series data in a consistent format are available for a wide variety of data categories. Changes in ground access market share by geographic area and travel market segment can be traced over several decades.
Four: **Understand patterns and demands.**	"Data collection and system monitoring shall be used by the States and local agencies to evaluate the performance of intermodal facilities and systems to determine the efficiency of the movement of people and goods."	Ground access problems can be identified, based on an understanding of existing and projected conditions and existing performance. Is demand skewed toward the central business district (CBD) or focused on some other concentrated district? Is congestion better or worse than it was 5 years ago? At times of greatest congestion, is the airport serving primarily resident nonbusiness travelers or nonresident business travelers? What will conditions be like 5, 10, or 20 years from now?	Path-breaking work undertaken at the San Francisco airport to understand and model existing conditions and patterns in ground access (e.g., nature of elasticities with relation to price of parking, evaluation of policy options for managing and regulating shared-ride van operators) for application to near- and long-term policy issues. The Washington, DC, MPO has prepared an airport ground access element as part of its airport system plan.

Table 2.1-1. Seven-Step Airport Ground Access Planning Process

Step	Basis in Regulations	Purpose	Examples in Airport Access
Five: **Develop alternative strategies and actions.**	"Statewide and local strategies and actions that improve the intermodal efficiency for the movement of people and goods shall be developed and evaluated. Methods for increasing productivity and the use of advanced technologies...shall be evaluated where appropriate."	Establish deficiencies of system at a level of detail that should help to define a reasonable range of alternatives for testing and evaluation. It is critical that the options considered include a full range of possible solutions, beyond the initial concepts of highway and rail. In San Francisco, the private sector has developed an elaborate shared-ride van system, with the public sector examining major options to provide the appropriate level of regulation to those services. Water transportation services are a part of overall strategies in Boston and New York and are under discussion in San Francisco.	Policies range from striping a curb that encourages non-SOV airport access to creating exclusive right-of-way service, such as at Cleveland, Chicago, and Atlanta. Physical examples include careful placement of public mode services at closer curb of main baggage claim area in New Orleans. Institutional examples include design of the franchise for ground access services at Charlotte or New Orleans and creation of a new taxi system at Dulles. The creation of a two-tiered service level concept at Toronto Pearson Airport responds to the sudden growth of unregulated limo and black car services around the world.
Six: **Analyze and evaluate alternative strategies and actions.**	"The evaluation program shall determine what project or combination of projects and actions would most effectively improve the intermodal productivity of transportation systems, in terms of the established performance measures, for both the short and long term."	Performance measures established early in the process are used to evaluate alternative actions and policies. The evaluation of alternative strategies can be based on indices that go beyond the analysis of vehicle flows and include such concepts as the mobility of people and goods and accessibility to various activities and land uses.	In the New York area, the airport access project is the subject of full major investment analysis, including preparation of a final environmental impact statement. In Salt Lake City, analysis of alternatives focused on near-term options to deal with a serious air quality nonattainment situation. In Boston, evaluation of alternatives shifted from an initial focus on availability of modes to an analysis of the total VMT implications of all modal options.
Seven: **Implement and monitor selected policy interventions**	"A process for periodic assessment of the effectiveness of implemented strategies, in terms of the area's established performance measures, shall be implemented. The results of this evaluation shall be provided to decision makers to provide guidance on selection of effective strategies for future implementation."	Strategies implemented are influenced by goals, objectives, and performance measures of specific cases under consideration. In Salt Lake, the dominant policy issue was air quality, not service quality; thus, the selected strategy changed the level of pollution from shuttle vans, rather than changing travel time. Salt Lake and Washington National provide space for all on-airport rental car operations in garages near terminals, eliminating VMT caused by multiple courtesy vehicles of separate rental car companies.	The Massachusetts Port Authority is monitoring and periodically reassessing its overall ground access strategy. The agency has monitored the air quality implications of its actions, ranging from parking pricing policies to monthly variations in ridership on its express bus services. A series of comprehensive ground access surveys is conducted every 5 years, which makes it possible to observe changes in the travel behavior of different market segments of users.

3. Collect data needed to support the application of the performance measures.

4. Understand existing and future conditions and performance of the system.

5. Develop candidate strategies and actions.

6. Assess effectiveness of alternative strategies and actions and select cost-effective actions.

7. Implement, monitor, and gather feedback using the established performance measures.

The cyclical nature of this program is illustrated in figure 2.1-1, which summarizes each of the seven steps and shows how program monitoring and feedback are used throughout the process. Table 2.1-1 describes the key aspects of each step, and the Federal regulations on which the steps are based and lists examples of airport access planning that illustrate the key issues in each phase of the seven steps. This summary gives particular attention to those steps in the process that have been given new or heightened roles by the ISTEA planning process, such as the importance of performance measurement.

A work program should be developed that defines how each step of the planning process will be carried out. This project plan should reflect the nature of the access problems under study and the levels of analysis appropriate to addressing the access issues.

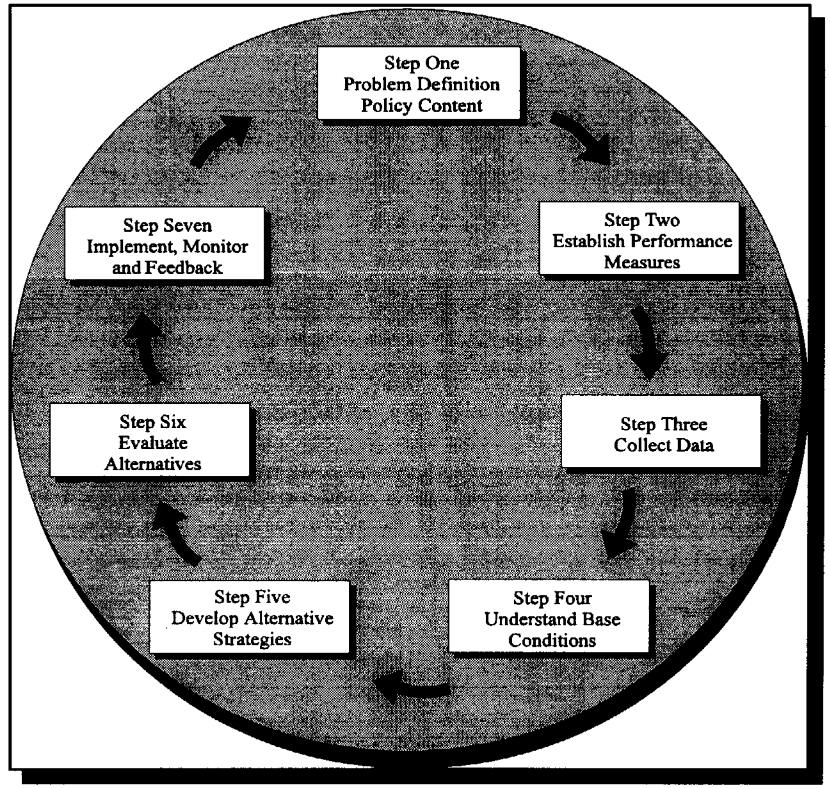

Figure 2.1-1. The Seven Steps of the Ground Access Planning Process

2.2 Problem Definition and Policy Context

The first steps in airport ground access planning include gaining an understanding of existing requirements for the planning of airports and regional transportation systems, coupled with a sensitivity to the policy issues of local importance. The following chapters are designed to help planners understand the specific steps in the airport ground transportation planning process. The first step addresses the purpose and need for improvements in airport ground access. This key step of problem definition must be undertaken in the context, and with the understanding, of a wide variety of legislative, regulatory, and institutional concerns. Some of these concerns are driven by the needs of the airport itself, while others are based on the need to participate in the region's comprehensive transportation planning and programming process. It is important that environmental concerns are integrated early in the process of identifying and selecting access improvements. Only environmentally acceptable access improvements will ultimately be accepted and funded.

Defining the Issues — Examples From American Airports

One key to a successful airport ground access program is initial understanding of the policy issues being addressed in the development of the program. The ISTEA planning process places a great emphasis on the early development of performance measures, which aid in monitoring existing conditions and predicting changes in performance as a result of the policy interventions under examination. The derivation of these performance measures and examples of their use are discussed in Chapter 3 of this guide. The key to successful selection of performance measures is the clear understanding of the public policy issues that are to be observed through the mechanisms of those performance measures.

Individual American airports have developed ground access strategies in response to very different policy concerns. These concerns range from a perception that lack of access is constraining economic growth to concerns that too much traffic stemming from rapid growth is causing environmental damage. The breadth of policy issues that lead to the adoption of an airport ground access strategy can be seen in the following examples from American airports.

<u>Poor Accessibility and Economic Consequences</u>

Perceived lack of accessibility is a key policy issue driving many efforts to improve ground access conditions. This is the concern of the Port Authority of New York and New Jersey, which has calculated that more than $20 million per year is lost to delays caused by congestion for JFK alone. This calculation includes lost income to air travelers; automobile, limousine, and taxi drivers; and airport employees.[1] This kind of inaccessibility has direct spinoff implications for the region's economy; the Authority reports that for firms leaving the greater New York City area, poor access to the airports is the second most frequently mentioned reason for dissatisfaction with the area. The Authority notes that usage of the New York airports has been stagnant recently. Much of the growth in international travel has shifted across the Hudson River to Newark, which has better travel times to the traditional financial districts and other adjacent markets. In a recent newsletter, the Authority compares this lack of usage with the experiences of Zurich, Frankfurt, and Washington, which have had continued air traffic growth in spite of poor economic conditions for the host economies.

Accommodation of Economic Growth

A desire to accommodate growth, with better service to the airport user, is a common motivation for investment in airport access. The total reconfiguration of the Pittsburgh airport, from a multifinger-pier airport to a modern midfield airside terminal configuration, caused the need for State highway investment to the new landside terminal area, in much the same way as Atlanta had done a decade before. A major partnership was born between the airport agency and the State highway agency to reconfigure the airport and prepare for its growth as a hub. Similarly, to provide infrastructure for continued growth, Las Vegas has now assembled an innovative financial proposal that calls for aviation funds to be used within the airport boundaries and for National Highway System (NHS) funding outside the airport boundaries. Other airports facing rapid growth, such as Manchester, NH, are working with State highway departments to plan and implement totally new access routes.

Localized Air Quality Problems

The desire to respond to regional air quality concerns has motivated the Salt Lake City airport to undertake a program to minimize particulate pollutants both at and away from the airport. The Salt Lake City airport is located in a different meteorological air basin from the downtown area of the city, and the airport is the chief activity center for this area. Thus, for the policy intervention under consideration in Salt Lake, the policy issue at hand is not the improvement of travel times to the airport (as is the case in the New York City project), but rather the reduction of particulates being created by airport-related activities. The response has been to develop a program to replace all diesel equipment on the airside with electric or compressed natural gas and begin a program to purchase natural gas vans for private operators of ground access services. By a creative use of on-airport user fee structures, the expense borne by the operator is returned by a lower fee structure. Note that this policy intervention does not increase the number of persons using the high-occupancy vans, decrease travel time, or change roadway congestion levels. Rather, it deals with the issue of particulate pollution, which is the specific environmental problem being faced.

Guaranteed Service Availability for Airport Passengers[2]

Dealing with the ground transportation needs of air passengers is a continuing reason to develop innovative programs in airport ground access. In Charlotte, NC, an exclusive franchise to sell tickets for shared-ride services has been granted to one company. In turn, this company must agree to provide at least two vans waiting at the baggage pickup curb at all times from 6:00 a.m. to midnight — whether or not there is any demand for the services. As part of the company's contract with the city, no one will wait for on-demand service for more than 15 minutes. Similar institutional arrangements were established in

1991 in New Orleans, when one shuttle van firm was given exclusive rights to sell tickets at the airport. As a result of this regulatory structure, the operators of this service have attained a load factor of 7.5 passengers per trip, which is exceptional for a small van operation. These two cities' experiences follow the development of a similar franchise concept at Washington's Dulles International Airport, which applies to all outgoing taxis, as well as shared-ride services. At Dulles, a holding company has been granted an exclusive right to pick up taxi patrons at the airport. That company, in turn, provides services through 285 owner-operated cabs. Each of these cabs can be no more than 4 years old and must meet strict standards of performance.

Environmental Mitigation for Surrounding Communities

The aggressive program to improve ground access services at Boston's Logan International Airport was developed to reduce the environmental damage being experienced by adjacent communities, most noticeably East Boston. For this reason, the alternative policies and scenarios examined for Logan Airport by Massport, the Massachusetts Port Authority, have focused on minimizing vehicle trips through the affected neighborhoods. One key factor being examined is the number of ground transportation trips caused by a given number of air traveler trips. In this evaluation system, a wide variety of strategies is examined to determine their impact on VMT generation. Massport planners have focused on strategies that can lower VMT experienced in the adjacent neighborhoods. Using a performance measure described in Chapter 3 of this guide, Massport planners looked at public policy interventions in terms of their abilities to effectively minimize VMT. In any given case, that policy might seek to encourage the pickup/dropoff trip to become a drive-alone/park trip. These concepts challenge some of the most fundamental performance measures used in areas other than airport ground access planning. A vehicle with two persons — one of whom will return home after dropping off the air passenger — is not considered to be more efficient than a vehicle with one passenger going directly to the parking garage. This performance measure was developed in response to an understanding of the policy issue defined for this particular airport — that of environmental disruption of adjacent communities.

Problem Definition — A Summary of Experience

For a rural airport experiencing sudden growth and severe isolation, the principal problem of airport ground access can often be quickly defined as a lack of high-quality roadway capacity. For an airport in an older metropolitan area suffering from nonattainment of air quality standards, such as Boston's Logan Airport, the problem of airport ground access is one of lowering VMT, even to the point of subsidizing services to accomplish this. For Charlotte, NC, the ground access problem was the lack of available services for air passengers. For Salt Lake City, the ground access problem was not travel time, but emissions of particulates. In each of these examples from American airports, the nature of the problem being addressed is first carefully defined. Based on this understanding of the unique circumstances of the individual airport, a program of ground access improvements can be developed.

This review of experience in problem definition at American airports suggests that the concerns leading to improvements in airport ground transportation fall into two categories: air quality attainment and congestion issues and other issues. For the airport manager in a region that has attained the national air quality standards and does not suffer from significant levels of congestion, the ground access issue turns to the standards of accessibility experienced by the user. For the airport manager in a region that must alter the emission generation of all mobile sources, the issue of airport ground access must quickly become part of a larger region-wide strategy to deal with mobile source emissions. This will affect the formulation of goals and objectives for the program and the nature of the implementation strategies that must precede funding for a successful program. In the following sections of this chapter, the roles of various agencies in the definition of relevant policy considerations will be reviewed.

2.3 Agencies' Roles and Regulations

Airport Planning

<u>The Airport Master Planning Process</u>

The establishment of basic policy direction concerning airport planning comes from several phases of the existing planning process. For the metropolitan area, the basic goals and objectives are outlined in the metropolitan transportation plan. The airport should also have its basic program for growth established in its own airport master planning process. The concept of including ground access consideration into that master planning process is not new; it is well-established in existing FAA guidance for the airport planning process. The FAA issued the following guidance on airport access plans in its *Airport Master Plans*, (Advisory Circular 150/5050-6a):

> This element of the airport master plan should indicate proposed or existing routes from the airport to central business districts and to points of connection with existing or planned ground transportation arteries and beltways. All modes of access should be considered including highways, rapid transit, and access by helicopters. The airport access plan should be of a general nature since detailed plans of access outside the boundaries of the airport will be developed by the highway departments, transit authorities and comprehensive planning bodies. Special studies of access systems beyond the airport boundary will normally not be included in a master plan effort.[3]

<u>FAA's Planning and Design Guidelines for Airport Terminal Facilities</u>

The concept that the details of the airport access plan must be developed with agencies outside the airport boundaries is further developed in Advisory Circular 150/5360-13, *Planning and Design Guidelines for Airport Terminal Facilities*,which states:

> Circulation systems within the airport boundaries should minimize congestion and support efficient access to the passenger terminal. Ground access systems extend beyond the airport boundaries and a thorough analysis of motor vehicle traffic flows associated with current and projected future air passenger demand is essential to assure that ground congestion does not become an unanticipated constraint on a passenger terminal's performance.[4]

Given that this "thorough analysis of motor vehicle traffic flows" should occur, and that these flows will happen primarily on facilities outside airport boundaries, the circular emphasizes that "local and regional transportation authorities, as well as public operators of ground transport services, should be included in the planning and design process." The circular also emphasizes that the ground access system should include more than highway access and incorporate public modes where appropriate:

> Public transit system service ground access to the airport, preferably the airport terminal area, should be considered. High-quality public transit service, as provided by rail systems or express bus operations, can attract significant ridership and help alleviate vehicular congestion in the terminal area. Easy direct access to terminal buildings, as well as baggage transport and security, are essential to encourage substantial passenger use.

The FAA documents make clear that airport ground access is an essential part of the airport's master planning and design responsibilities and, at the same time, "must function within the context of regional transportation systems and the policies of Government agencies typically unrelated to the airport's operation." A main purpose of this guide is to document the nature of the planning process and to aid practitioners in building partnerships between on- and off-airport planning and activities.

State and MPO Airport Ground Access Planning

<u>The Transportation Planning and Programming Process</u>[5]

Both States and MPOs are involved in airport ground access issues at two levels, *planning* and *programming*. When an airport access project has been defined, its costs have been assessed, and an environmental analysis performed, the proponent must be skilled at the task of obtaining funding through the programming process. Long before the stage of clear project definition, however, the subject of airport ground access is developed and analyzed in the planning process undertaken at both the State and MPO levels. The proponent of airport access improvements needs to develop an understanding of both these critical areas. The major steps of the planning and programming processes are summarized in figure 2.3-1.

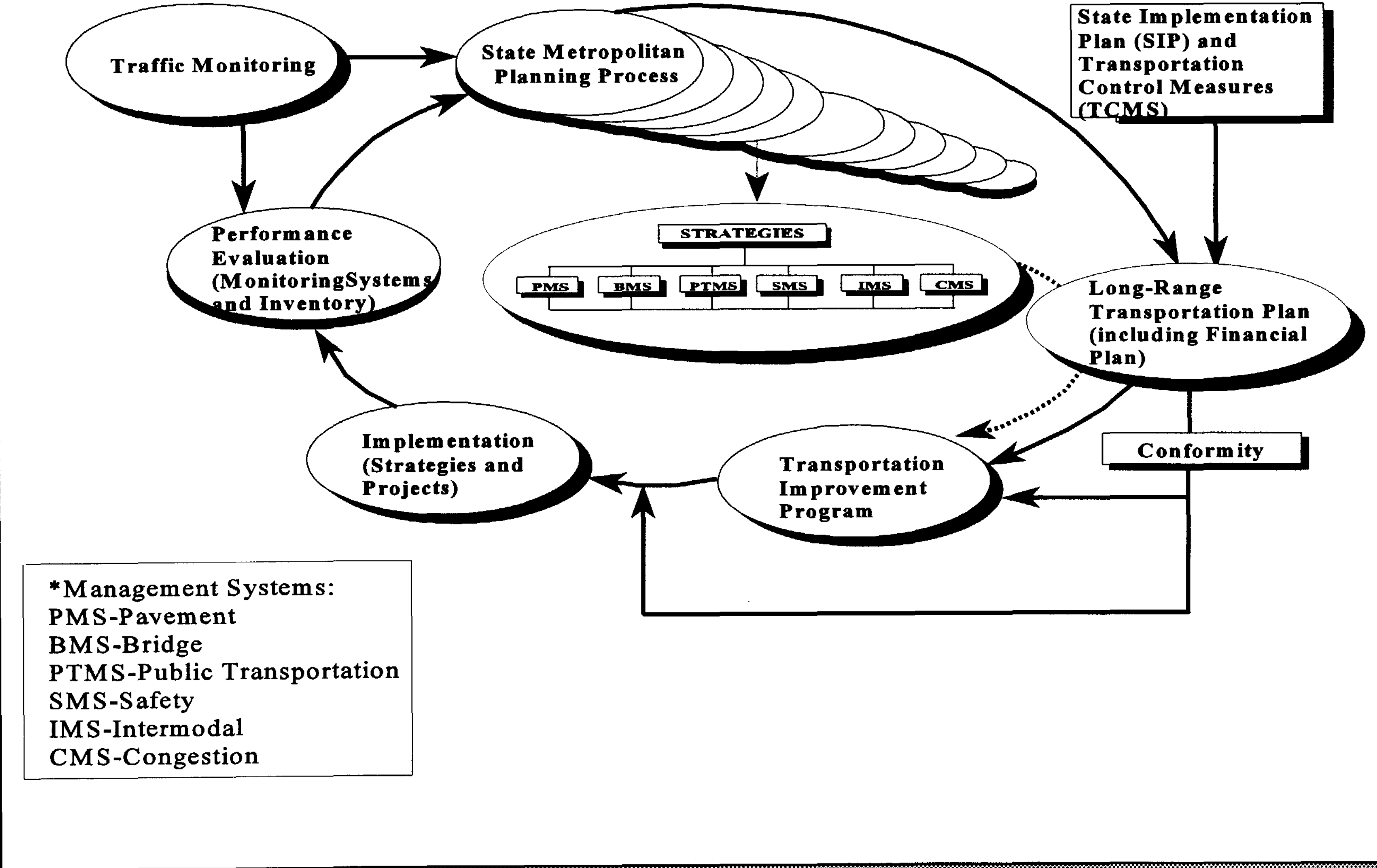

Figure 2.3-1. The FHWA Planning and Programming Process[6]

The transportation planning process is represented in figure 2.3-1 as a multilayered process, expressed in the diagram in three dimensions. The time orientation in this planning process is long term, 20 years or longer. This time frame allows the thoughtful analysis of such issues as land-use change and land-use policy, which require the longer time orientation. The Joint Planning Regulations state: Addressing at least a 20-year planning horizon, the plan shall include both long-range and short-range strategies/actions that lead to the development of an integrated transportation system that facilitates the efficient movement of people and goods." The plan must be updated at least every 3 years in air quality nonattainment areas and every 5 years in attainment areas.

Included in this transportation planning process are such dimensions as energy policy, freight planning, and system preservation. One of the key "layers" in this transportation planning process is the management systems. As described later, management systems represent a major tool for analyzing the success or failure of ground access to intermodal facilities, such as airports. Within this multifaceted planning process, revealed needs are analyzed; from this analysis stems the development of proposed projects for implementation.

During the planning phase, the process is not driven by the image of the desired facility, but rather by the analysis of need. In the planning process, solutions that are based on policies — such as changes in pricing, regulation, or management strategy — are given attention equal to that of solutions that involve traditional capital investment concepts. These projects and policies are assembled into the long-range transportation plan, as illustrated by the arrow feeding from the planning process to the plan. From the longer list of projects in the transportation plan, a shorter range transportation improvement program (TIP) is created. "The TIP shall cover a period of not less than 3 years, but may cover a longer period. . .the priority list shall group the projects that are to be undertaken in each of the years. . ." [7] Beyond the 3 years, the priorities can be more loosely defined. A project that appears on the first year's priority list (often referred to as the annual element of the TIP) is eligible for Federal funding in that year.

The ISTEA process of planning and evaluation continues with the monitoring and gathering of the actual performance results of the projects and strategies implemented. This performance information serves as input to the continuing transportation planning process. Note that this process applies to both metropolitan- and State-based planning and programming. For most airport ground access improvements, the primary location for programming activities is the MPO. For that reason, the discussion that follows focuses on planning and programming activities at the MPO level. In most cases, as projects are developed at the regional level, the statewide programming functions incorporate the results of regional decisions with a process that parallels that of regional approvals.

> *Section 1024 of ISTEA requires that metropolitan planning incorporate 15 factors, including:*
> *"International border crossings and access to ports, airports, intermodal transportation facilities, major freight distribution routes, national parks, recreation areas, monuments, historic sites and military installations."*

The Management Systems[8]

As illustrated in figure 2.3-1, within the layers of tools and considerations of the transportation planning process, the management systems are a key element in developing an understanding of transportation needs and analyzing potential strategies to deal with those needs. For the proponent of airport ground access improvements, two of the six management systems noted in figure 2.3-1 are the most important: the CMS and the IMS. The ISTEA mandates certain major shifts of emphasis in the transportation planning process. Some of these changes are designed to better support the relationship between planning and the implementation of the Clean Air Act, as amended. Others are related to a major theme of the ISTEA legislation, that of accountability, which brings about a new emphasis on the monitoring and continued evaluation of the implications of strategies and actions undertaken. Both the CMS and IMS have been developed to both monitor the status of the system and allow for quick evaluation of conceptual plans and strategies to deal with the problems of the system revealed through the program of monitoring and gathering feedback.

CMS

The planner of airport access improvement in an area where congestion is a concern has to be aware of the importance of incorporating non-SOV elements into the access program whenever possible. This will maximize the chances of attaining funding for proposed improvements that may increase general-purpose travel capacity. Note that strategies to deal with the increased highway capacity are not limited to the actual roadways under consideration for funding. Once a decision has been made to include a highway that expands capacity, the CMS program is expected to provide for programs throughout the corridor in which the new facility is located:

> The CMS shall provide an appropriate analysis of all reasonable (including multimodal) travel demand reduction and operational management strategies for the corridor in which a project that will result in a significant increase in capacity for SOVs (adding general purpose lanes to an existing highway or constructing a new highway) is proposed.[9]

The legislation is specific concerning the range of strategies to be considered in a CMS. The regulations call for "considering strategies that reduce single occupant vehicle travel and improve existing transportation system efficiency."

> *The CMS is "a systematic process of: identifying and implementing strategies that provide the most efficient use of existing and future transportation facilities in all areas of a State. . .where congestion is occurring or expected to occur, considering strategies that reduce single occupant vehicle travel and improve existing transportation system efficiency."*

The CMS plays a major role in determining the eligibility of major improvements, such as the creation of a new highway to serve an airport. Of particular importance to the development of airport access plans and strategies is the policy mandate established by ISTEA concerning the construction of general-purpose roadways or roadway facilities that do not give priority to HOVs. Section 450.320(b) of the State and Metropolitan Planning Regulations states that:

> [in areas] designated as non-attainment for ozone or carbon dioxide, *Federal funds may not be programmed for any project that will result in a significant increase in carrying capacity for single occupant vehicle* (a new general purpose highway on a new location, or adding general purpose lanes, with the exception of safety improvements or the elimination of bottlenecks) unless the project results from congestion management system (CMS). . .

IMS

The purpose of the IMS is summarized in the ISTEA planning regulations that call for the State to develop "an IMS that provides efficient, safe and convenient movement of people and goods through integration of transportation facilities and systems and that improves the coordination in planning and implementation of facilities for air, water and the various land-based systems." The IMS was developed to help focus policy attention on issues, such as airport ground access, where the planning of one mode should become better integrated with the planning of other modes. Airports are clearly one of the "intermodal facilities" for which the system is designed. An intermodal facility is defined in the regulations, as "highway elements providing terminal access, coastal, inland and Great Lake ports, canals, pipeline farms, *airports*, marine and/or rail terminals, major truck terminals, transit terminals including park and ride facilities, and intercity bus terminals."

Strategies That Must Be Considered for Congestion Management Systems

- Transportation demand management
- Traffic operation improvement
- HOVs
- Public transit capital and operation improvements
- Nontraditional modes (e.g., bicycles and pedestrian facilities)
- Congestion pricing
- Growth management and activity center strategies
- Access management techniques
- Incident management
- Intelligent transportation system (ITS) technologies,
- Addition of general purpose lanes.

For many airport access issues, the IMS can be seen as a highly specialized subset of the CMS, which calls for policy attention at specific subelements of the system. While the CMS examines the quality of mobility of people and goods for large-scale systems (in all areas where congestion exists or can reasonably be expected), the IMS focuses on the relatively smaller set of facilities and services, generally referred to as "intermodal facilities." Once the problems of this subset of the transportation system are defined, the intended goals of policy interventions are essentially the same as those goals defined by the CMS: to improve the mobility of people and goods and to make most efficient use of the existing system.

The IMS is a "systematic process which: identifies key linkages between one or more modes of transportation where the performance or use of one mode will affect another, defines strategies for improving the effectiveness of these modal interactions, and evaluates and implements these strategies."

The IMS process is inherently different from the CMS process in several ways. First, while the CMS process is often developed and managed at a metropolitan level, under the general supervision of the State, the IMS is clearly a statewide function. Second, the IMS process is less closely linked to sanctions than the CMS. Failure to include a proposed airport access road in the CMS process could make Federal funding impossible. The IMS, by contrast, presents an opportunity for the airport ground access planner to bring the problem of inadequate access to the State programming process, where it must be at least addressed at the level of detail appropriate for the management systems. In many ways, the IMS process serves as something of a warning flag that signals the existence of a problem in the overall performance of the system.

Role of the Major Investment Study (MIS)

A key element in the transportation planning process for airport ground access solutions is the development of specific projects that require significant capital investment. The metropolitan transportation plan is developed by first undertaking a regional system level analysis that involves the entire geographic area and provides an understanding of the needs of the full system. Corridors and subareas are then defined for more detailed development of projects and policies. The process by which the data describing need for transportation improvements are transformed into specific projects, policies, and actions for corridors and subareas is called the MIS.

To define a corridor or subarea, the MIS planning regulations refer to a "set of travel markets affected by mobility problems/needs and possible transportation improvements," based on the understanding of a specific set of origins and destinations. A "travel market affected by mobility problems" for an MIS could be defined as all trips to and from the airport. The MIS must be undertaken in a metropolitan area when the need to consider a major transportation investment has been identified by the planning process and where Federal funds might become involved, even at a later date.

Figure 2.3-2 shows the five steps for conducting an MIS, which include:

- Initiation
- Development of initial set of alternatives
- Screening and decisions on the detailed set of alternatives
- Analysis, refinement, and evaluation of the alternatives
- Selection of the preferred investment strategy.

At the end of the MIS, the project has been defined in terms of mode and scope (e.g., number of through-lanes). The project development phase then follows. The purpose of project development is to examine design options *within the established concept and scope*. This can only happen to a project that has been accepted in the TIP (and on the revised plan, if needed). From this point, serious design options, such as the location of stations and specific right-of-ways, can be analyzed.

For some projects, the filing of the draft environmental impact statement (EIS) will come at the completion of the MIS; for others, the draft EIS will wait until the development of design alternatives in order to discuss them. The final EIS then documents the design alternative proposed for implementation. As always, the National Environmental Protection Act (NEPA) process is not completed until the final EIS is accepted, through the record of decision.

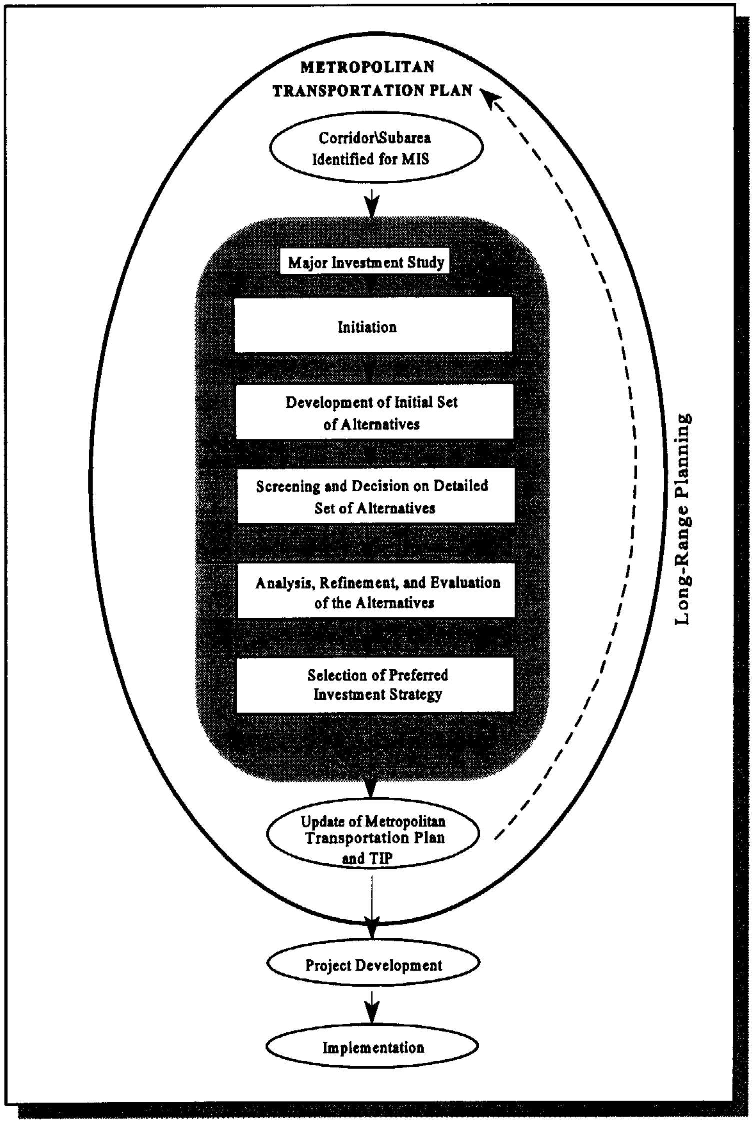

Figure 2.3-2. Major Investment Study Process [8]

Relationship Between Airport Access and the Clean Air Act Conformity Regulations[11]

With the completion of the MIS phase, the proposed airport ground access project is defined in terms of design concept and scope (e.g., the project has been determined to be a freeway of six lanes). With this new level of detail, the relationship of the proposed project to regional air quality attainment can be calculated. For a project seeking highway or transit funding (as opposed to FAA funding), the project must be reviewed for its conformity with the state implementation plan (SIP) for attainment of clean air standards under the "transportation conformity" rules. With the new information about the design concept and scope of the project emerging from the MIS process, the project must be added to the existing metropolitan transportation plan to ensure that the plan still conforms to the SIP.

For areas that are suffering from nonattainment of certain air quality standards, the State is required to prepare a SIP that commits to a plan that brings the region's air quality in compliance with national standards. According to the regulations, the metropolitan transportation plan can only be approved if it is consistent with the SIP. As new projects are developed, they must first be added to the transportation plan; the plan is then checked for conformity with the SIP and projects from the plan are added to the TIP. The TIP is then reexamined for its conformity with the SIP. In making this determination, the managers of the SIP must determine that these projects will "not cause or contribute to new violations of air quality standards, exacerbate existing violations, or interfere with timely attainment or required interim emission reductions towards attainment." [12]

Programming Highway and Transit Projects for Airport Access

For airport access projects in regions with nonattainment status that require either highway or transit funding, there are three steps that will be used to review candidate projects for conformity with air quality requirements. The upper third of figure 2.3-3 shows that the metropolitan transportation plan is tested against the no-build base case to determine whether the implementation of the plan would bring about conformity with the air quality improvements required in the SIP. If it does not bring about the desired improvements, then either the plan or the SIP must be revised. If the metropolitan transportation plan does conform, the projects in the plan can be inserted into the 3-year program of priority projects known as the TIP. No project outside the metropolitan plan can be added to the TIP.

Even if an access project is not expected to use Federal highway or transit funds, certain provisions of the transportation conformity rule may apply to the project. All "regionally significant non-Federal projects" (i.e.,any facility serving major activity centers and other regional needs) must be included in the regional emission analysis for a transportation plan or TIP (40 CFR 93.103/40 CFR 51.452). In addition, no agency that receives Federal highway or transit funds may approve a regionally significant highway or transit project, *regardless of the funding source*, unless it comes from a conforming plan and TIP, is in the regional emission analysis

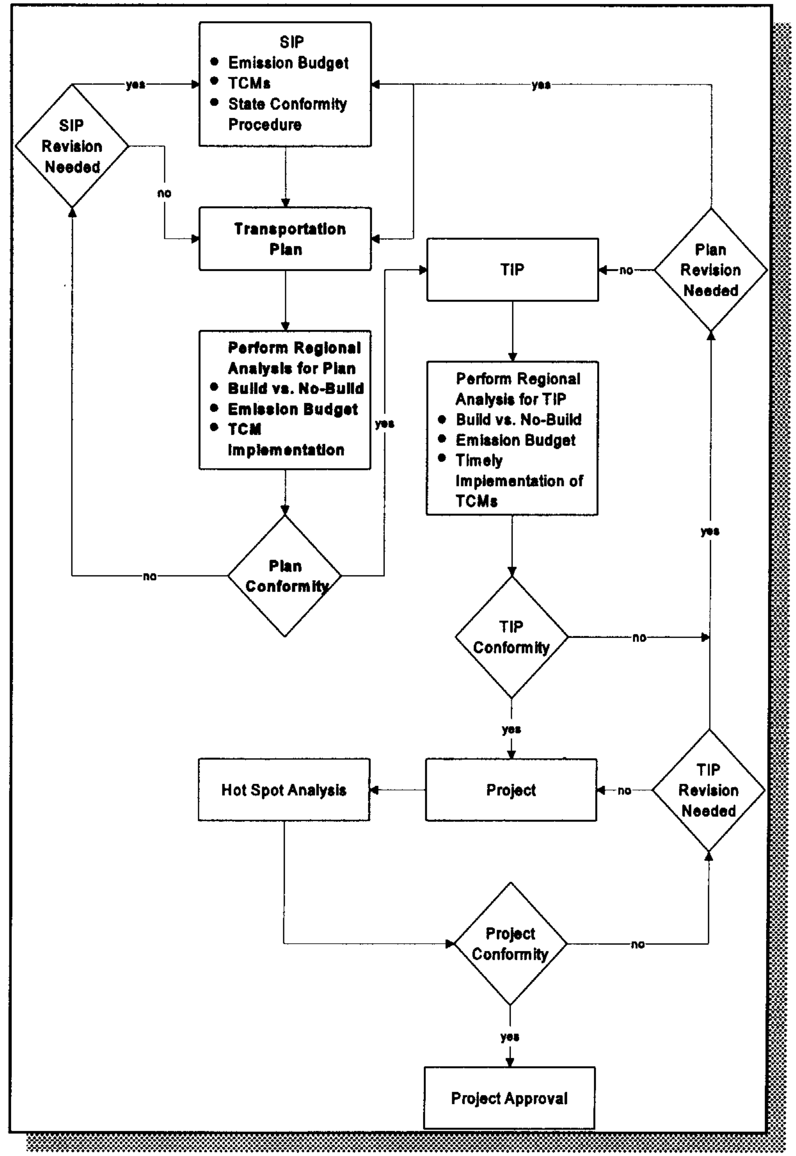

Figure 2.3-3. Transportation Conformity Process[11]

supporting the currently conforming TIP, or meets other tests (40 CFR 93.129/40 CFR 51.450).

It is important to note that at this early stage of project definition and development, the candidate project may not be defined to the level of *design concept* and *scope* necessary to understand its particular impact on regional emissions. (Design concept refers to the nature of the facility, such as a freeway or rail line, while scope refers to the number of lanes or tracks). If the required MIS for the candidate project is not completed, the metropolitan transportation plan can proceed with a "place-keeper" element that can take two forms. The plan can contain a "best guess" of the outcome of the MIS or the no-build case for the candidate project. After the MIS has defined the design concept and scope for the project, the plan must again be examined for conformity in order for the candidate project to be carried into the TIP.

Assuming that the plan achieved conformity status with the SIP, the selected projects of the TIP are now examined for their collective impact on conformity with the requirements of the SIP. As shown in the middle third of figure 2.3-3, if the TIP is found not to conform, changes must be made in the TIP, the plan or the SIP to achieve conformity.

As the TIP-approved project continues its project-based EIS, the third check for conformity occurs, as shown in the bottom third of figure 2.3-3. By this time, the proposed alternative within the established design concept and scope has been selected, and the project has sufficient detail to forecast its impact on relevant intersections and "hot spots" for carbon monoxide. With these data, the project itself is tested for its conformity with the requirements of the SIP.

Determining Conformity Under the General Conformity Regulations

The process summarized in figure 2.3-3 is required for those projects funded through the various sources available to finance highway and transit improvements. Funding action involving the FAA, on the other hand, is covered under the "general conformity regulations" that cover most other Federal expenditures. As the final rule notes, "the general conformity rule covers all other Federal actions, including those associated with railroads, airports, and ports."[13] In overall intent, the process is similar. In order to be found in conformity with the SIP, a given project, such as a new airport parking garage, must be found not to cause a new violation, worsen existing violations, or slow down the schedule for attainment established in the SIP.

It is important to understand the type of air quality impact that an airport may be required to examine. The EPA has made it clear that the general conformity rule will cover new emissions, both direct and indirect, that are reasonably foreseeable, that FAA can practicably control, and over which the FAA will maintain control through a continuing program responsibility. Airports should check with the appropriate FAA Airport District Office to determine the need for determining air quality impact under the general conformity rule.

To fully understand the implications of the general conformity regulations for airport ground access, it is important to examine the kind of air quality impact for which the airport must develop a mitigation program. The EPA has made it clear that the general conformity rule will cover the indirect emissions caused by vehicles coming to and going from the new facility.

This clarification has considerable impact on the study of access to intermodal facilities and to airports specifically. The regulation establishes that when an airport operator intends to spend Federal funds on a project within the boundaries of the airport, the air pollution emission impact experienced off the facility should be documented to the standards required by the SIP. In short, this means that airport operators should become involved in the development of mitigation measures that minimize the growth of SOV travel, (i.e., the list of policy options that is the focus of the CMS). For the airport operator, the general conformity determination may require examination of the air quality implications of the proposed investment in two situations: First, general conformity determination may be necessary for investments affecting patterns of ground access directly, such as the investment in a new or widened airport access road on airport property. Second, conformity determination may be necessary when seeking Federal funds for airport improvements not primarily associated with access, but which, for one reason or another, increase the number of vehicles coming to the airport. In both situations, the airport operator should become a partner in the development of the region's CMS and other actions to bring the region into attainment status for air quality.

<u>Federal Funding Under the General Conformity Regulations</u>[15]

An airport operator who intends to spend airport PFC funds on a project to improve ground access within the borders of the airport must follow the procedures defined for general conformity determination. However, the general regulations allow for the transportation investment to use procedures established under the transportation regulations if the proponent succeeds in having the MPO place the project on the metropolitan transportation plan. If it is included in the plan, the project can attain approvals under the process described in figure 2.3-3.

At local discretion, the airport operator can proceed under the provisions of the general conformity regulations, which require that more work is done by the proponent and less by the MPO process. The advantages of this option stem from the fact that the proponent can proceed independently of the MPO and its cycle of SIP approvals and revisions. However, the subject of airport ground access usually involves considerable intervention off the airport property and will, by its nature, require assertive cooperation and coordination with the State and MPO planners. Given these considerations, the adoption of the transportation conformity regulations for programs of airport access improvements often represents the most prudent and cautious approach to conformity determination.

Further, because an airport access improvement is likely to be subject to the non-Federal project requirements of the transportation rule, it must be included in a regional transportation emission analysis. This also argues for using the MPO process for completing conformity. Another argument for using the MPO process is that, through that process, airport access improvements can be coordinated with other agencies and operators.

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CHAPTER 3

PERFORMANCE MEASURES

3.1 The Logic of Performance Measurement

It is a characteristic of the planning process mandated by ISTEA that the rules for program monitoring and evaluation be established early in the cycle. The planner is asked to determine at an early juncture what measures of performance and effectiveness will be used in the program of monitoring and evaluation. It is particularly important that the key issues for monitoring be well established and agreed upon before major, and possibly expensive, data collection efforts are begun.

This chapter of the guide has been prepared to help local planners and administrators develop goals, objectives, and performance measurements that are relevant to the needs of the local community. Efforts at developing performance measures in Oregon and Boston are summarized in this section. Chapter 3 ends with a proposed basic list of areas for performance evaluation by those just starting the process of ISTEA-based planning for airport access improvements.

In this guide, the concept of performance measurement is presented for application in two different contexts. First, performance measurement at the system level is a key concept in two of the ISTEA-mandated procedures, the CMS and the IMS, discussed in Chapter 2. In these two important procedures, the effectiveness of strategies to improve airport ground access is examined at a system level. In any given State, the statewide IMS might make observations concerning the characteristics of ground access for 10 separate airports. Thus, the performance measures used in statewide planning will focus on the overall adequacy of the system, rather than on the details of any given airport. Often, this region- or statewide-oriented process serves as an early warning alarm that access problems exist, particularly when compared with the same aggregate-level observations for other facilities.[1]

Detailed programs to deal with deficiencies observed using the two management systems (IMS and CMS) are often developed at the facility level, which is managed in most cases by the airport owner/operator. In many cases, the goals, objectives, and measures developed and applied at a regionwide or statewide scale will have qualitative differences from the goals, objectives, and measures developed and applied on a site-specific basis. This is because their functions are somewhat different. In a hypothetical example, queues extending into the arterial road system might be documented in a statewide or regionwide management system. In the statewide analysis, the measures might focus on the impact experienced on the State highway. The measures established would be appropriate for this scale of observation. The airport facility manager, on the other hand, looking at the same problem, might want to study curb dwell times or alternative curb management strategies. This guide has been designed to be of value to both those responsible for observing the performance of the system at the statewide or regionwide level and those charged with dealing with performance at the facility level.

3.2 Examples of Performance Evaluation Measures From Two States

Oregon IMS Work Program

An excellent example of the kinds of considerations appropriate at the statewide level is provided in the Oregon IMS, one of the most respected management system efforts in the country. The list of goals, objectives, and performance measures in table 3.2-1 shows a classic formulation of statewide system-level measures.

Goal: Accessibility/Availability. To meet the general policy goal of improving accessibility and availability, the Oregon work program defined three specific objectives:

1. *Minimize travel time to service*. To measure performance relating to this objective, base case travel times are collected to major activity centers or to the major connecting highway. After the creation of alternative strategies and actions for testing, various strategies are evaluated in terms of their effects on travel time. In theory, this performance measure should not be biased toward any one mode and could be used to measure the impact of a wide variety of strategies, from changes in regulation of taxicabs to addition of new transportation facility capacity. The use of this measure requires the existence of some method of calculating change in door-to-door times. A fully operational network simulation can be used for developing this measure.

2. *Optimize access for the disabled for connecting services*. The issue of Americans with Disability Act (ADA) compliance within the IMS is a sensitive one. In general, the IMS is considered to be a relatively ineffective mechanism for enforcing the provisions of the ADA. However, the field surveys associated with the IMS represent an opportunity for recording and assessing the quality of access for all persons, including those with disabilities. In the examination of the quality of airport ground access, the focus of the analysis would be more toward the ability to make connections at the terminal facility, rather than with the architectural details within the facility. However important these details may be, there are more effective mechanisms of enforcement for them than the system-oriented IMS.

3. *Provide capacity for peak hour loads*. The Oregon system places the observation of level of service (LOS) and the queuing of vehicles — perhaps the

most common measures of the quality of airport access — under the objective of accessibility/availability. In terms of monitoring, the expedient of observing the characteristics of queues can be used, providing it is done in a systematic manner. LOS observations at the terminal area are discussed in Chapter 5 of this guide. This measure is oriented to capacity observations, such as volume to capacity (V/C), rather than user-based travel times.

Goal: Affordability/Cost Minimization. To carry out the general goal of improving affordability in airport ground access, the Oregon program called for two specific objectives:

1. *Minimize external and direct social costs.* The external costs of airport ground access should be carefully broken out from the external costs of the airport operation itself. Thus, the burden of noise from airplanes experienced by a neighboring community would not be included in an IMS, while the burden of increased noise and pollution stemming from airport-generated traffic in a community would be appropriate for inclusion in the IMS. Measurements here include the classic issues for roadway external impact, i.e., air, noise, community disruption, impact on historic sites, and the like. Under this objective, the Oregon work program also makes reference to subsidization — are the costs of airport ground services being borne by groups other than airport users?

2. *Minimize capital costs.* Under this potential performance measure, the capital cost implications of candidate strategies and actions must be noted and evaluated. The extent to which this is a measure of the "performance" of a system can be debated. Cost can be viewed as a constraint within which various levels of performance are examined; however, if a policy goal of "minimize cost" is established, then saving expenses can be seen as a measurable level of performance.

Goal: Connectivity Between Modes. To carry out the general policy goal of improving connectivity between modes, the Oregon program established three specific objectives:

1. *Connect major routes to local modes.* The quality of connection between modes is the major focus of attention of the IMS. To measure this aspect of quality, a useful surrogate is the wait time (or layover time) between modes. The schedules of the connecting carriers can be used to build the base case data description. For example, service to a given town center by limousine might be every 2 hours in the base case and every 70 minutes in the proposed candidate strategy. A logical composite would look at service intervals for all modes combined. Thus, combining scheduled bus service and airport limousines, the town received service every 90 minutes.

Table 3.2-1. Oregon IMS Goals, Objectives, and Performance Measures [2]

Goals	Objectives	Performance Measures	Data Needed	Source of Data
Accessibility/ Availability	Minimize travel time	Travel time to major destinations	Airport and State transportation facility information, population and employment data, regional Transportation Simulations	Should be available from regional transportation simulations
	Optimize ADA access	Extent of attainment of ADA compliance	Airport compliance schedules	On-site inventory of compliance
	Provide peak capacity	Extent of vehicle queuing and overall delay	Quantification of observed delay and backup	Review carrier logs for on-time performance
Affordability/Cost Minimization	Minimize social costs	Subsidies and environmental costs	Revenue recovery, quantified pollution costs	FAA summaries, including subsidies, environmental models
	Minimize capital costs	Maximized use of existing capacity	Cost models, condition ratings	Master plans, construction cost data, inventory
Connectivity Between Modes	Connect to major routes	Service availability, layover times between modes, travel times	Schedules, limo/bus timetables	Review plans, conduct on-site inventory
	Provide access between modes	Parking space per passenger, limo space per passenger, loading area per passenger	Passenger counts for parking/loading areas	Review plans, conduct on-site inventory
	Promote easy transfer between modes	Time and distance of transfer between modes is less than *N* minutes and *N* feet	Facility plans and specifications, surveys, field data	Conduct inventory, survey customers on quality of transfer

Table 3.2-1. Oregon IMS Goals, Objectives, and Performance Measures [2]

Goals	Objectives	Performance Measures	Data Needed	Source of Data
Convenience/ Maximization of Benefits	Make transit as convenient as possible	Availability of remote intermodal ticketing and luggage support	Existing ticketing choices	Inventory existing services and timetables
	Publicize information on intermodal service available	Level of dissemination of information on options	Existing information/ knowledge of intermodal services	Inventory of existing information strategies, consumer surveys
Flexibility	Have options available for bus, limo, and shared-rider services	Availability of ground access options	Inventory of services available	Conduct inventory of existing choices
	Maximize schedules	Round trips/day between commercial airports	Schedules	Review timetables
	Provide frequent HOV service to airports	Set classification system by market density	Schedules	Review timetables
Mobility	Make airport limo/bus service competitive with autos	Ratio of travel times	Travel times and speeds	Travel time studies, schedules
Reliability	Improve on-time performance at terminals	Percent of aircraft and surface transport departures outside of 15-minute schedule	On-time performance data	Internal logs of carriers
Safety	Improve safety in both air and connecting modes	Accidents per passenger mile	Accident frequency and severity data	Collect data from police and FAA
Legal/Regulatory	Reduce obstacles to service provision	Decrease in limitations to use of facilities by HOV modes	Synopsis of current regulations	Survey users and service providers
	Encourage innovative service	Extent of innovative management	Synopsis of current regulations	Survey users and service providers

2. *Provide access between modes*. This is a capacity measure, which looks at facility capacity, including such observations as number of spaces per bus, spaces per limousine, and parking spaces per user. This could be a very important measure during periods of transition, such as are currently being experienced by many airports that do not have facilities to deal with the sudden growth of prearranged private limousines, also known as black cars. These data would provide a quantitative base on which to deal with the difficult issue of allocating curb space among vehicle categories. For areas with no air pollution issue, more parking spaces per user would be considered desirable; for areas using travel demand management strategies, maximization of available parking spaces may or may not be considered a desirable policy goal.

3. *Promote easy transfer between modes*. This measure would observe both the time and distance of transfer, perhaps expressed as percentage of transfers that take place in under x minutes or y feet. Unlike many operation-oriented measures, this measure assists in critiquing the design of existing facilities and developing designs for new or altered facilities. It could also be seen as a design standard, which is somewhat different from a performance measure.

Goal: Convenience/Maximization of Benefits. To carry out the policy goal of improving convenience and maximizing benefit to the users, the Oregon work program defined two objectives:

1. *Make public modes convenient*. Under this category, a review would be undertaken of strategies available to encourage the use of higher occupancy vehicle modes. Included in such possible strategies are the use of off-site check-in facilities and various schemes to aid with baggage. As a performance measure, a simple check-off of the existence or nonexistence of such strategies would serve as the tool of measurement. In the base case condition, for example, none of the possible strategies would be recorded as in place; in the candidate strategy, one airport might offer free sky cap service to the bus plaza or provide no-cost baggage carts between drop-off points and the interior check-in area. The description of this review as a performance measure could be debated.

2. *Publicize information on service availability*. An important measure of the quality of airport access is the availability of information to the public concerning airport access options, particularly those that use higher occupancy vehicle services. Thus, one measure of the performance of the system is the review of existing strategies and their effectiveness. The most desirable tool for this measurement would be a home interview survey, gauging the extent of knowledge of access options for frequent and infrequent users alike. A lower cost means of data

collection would be a subjective review of the available public information mechanisms, including the extent of distribution of schedules.

Goal: Flexibility. To implement the policy goal of maximizing flexibility for the users of airports in Oregon, the work program defined two objectives:

1. *Offer modal choices to/and from the airport.* One of the most basic categories of data to collect in the study of airport access is the existence, or lack of existence, of alternatives to the private automobile. When beginning an examination of ground access conditions, the very first element of data to collect would be the simple presence of various modes, while the *attributes* of the modes and the quality of their services would be analyzed at a later step. In addition to observing the attributes, the program must also record the performance of the system, often measured in terms of the number of riders choosing higher occupancy vehicle modes. The performance of these various modes is analyzed most directly by examining their mode shares. Mode share compared to non-single-occupant modes is one of the most effective measures of the performance of the system, in terms of its contribution to CMS and IMS strategies of the region.

2. *Maximize schedules.* In the Oregon transportation plan, specific service standards are established for air service within the State. This measure is more appropriate for the discussion of a statewide system plan than for a discussion of ground access.

3. *Provide frequent HOV services to the airport.* This measure would document frequency of service and is largely overlapped with earlier measures that observe waiting time (or layover time) between services.

Concerning the policy goals of increasing mobility, reliability, and safety for users of ground access systems, the Oregon work program defined these objectives:

Goal: Mobility. Make HOV modes competitive with auto. Mobility for non-SOV mode options is best documented by overall travel times experienced by the user. Surveys of the actual experiences of the user (including delays associated with the shared-ride concept) should be undertaken. Other measures of comparative mobility include comparative speeds (these same data can be expressed as comparative average speeds) or comparative average travel times over a specified distance. In California, a "mobility index" has been created that calculates (in effect) vehicle speed times vehicle occupancy to create an index of the mobility provided by a given facility.

Goal: Reliability. Improve on-time performance for connecting mode. It is important to document the extent to which service providers actually produce services on time, particularly when the user may be waiting outside at the curb area. Collecting these data requires some level of selfreporting from the service providers. Percentage of service that leaves more than 15 minutes behind schedule is recommended as a performance measure in the Oregon work program.

Goal: Safety. Improve safety on modes and in terminals. Accidents per 1,000 passenger miles can be obtained from police or public utility commissions. Crime reports and accidents in the parking lots can be recorded. In the Minnesota IMS work program, for example, the first performance measure established concerned the perception of safety from crime experienced by the customer. The second measure was the empirical data on reported crime.

Goal: Legal/Regulatory. Two objectives are noted under the broadly defined "goal" of legal and regulatory reform:

1. *Reduce obstacles to service provision.* While finding measures of performance in this area may be difficult, it is clear that the extent to which service improvements are being constrained by regulations should be documented. Forming a measure of regulatory "user-friendliness" is probably unnecessary. The Oregon document suggests a "synopsis of current regs."

2. *Encourage innovative service.* The extent to which existing legal and regulatory mechanisms facilitate public-private partnerships is included in this category. Again, what is proposed is less a measure of performance than a survey of existing conditions that could be improved.

Development of a New Performance Measure at Boston Logan International Airport

While the Oregon IMS serves as an example of the integration of statewide policy issues with the observation of performance in airport access, Boston's Logan Airport can be used as an example of the development of a facility-based program of performance measurement. As noted in Chapter 2, a key question in the definition of policy objectives concerns the attainment status of the region in terms of the Clean Air Act. Boston has a serious air pollution problem, which is particularly intense in many neighborhoods surrounding Logan Airport. Thus, great emphasis has been placed on the development of strategies that will minimize the environmental implications on the adjacent neighborhoods.

In the 1970s, one commonly used measure of success of the ground access strategy was rail transit mode split. During the late 1960s, a variety of possible investments in rail transit to Logan were examined, with a prediction of the change in mode split to rail as a principal evaluation measure. During the 1970s, the percentage of air passengers arriving by car fell sharply, and growth in higher occupancy vehicle modes occurred. Over a 20-year period, the mode split to rail transit grew from 6 percent to 8 percent, while the mode split to buses and limousines grew from 4 percent to 16 percent. Thus, with the conscious development of a ground access strategy in the 1970s and 1980s, mode split to all HOV modes (including rail transit) received considerable policy emphasis.

With the passage of the Clean Air Act, it was necessary to examine all the policy options available to control the growth of VMT to Logan Airport. It became clear to policy makers that not only was it important to examine the percentage of passengers coming by nonauto modes, but also to examine significant variations within the auto mode. Early in the 1990s, Massport policy analysts developed a new tool based on a very robust performance measure. Table 3.2-2 shows the relationship between major mode choices and the actual number of vehicle trips using the roadways near the airport. Table 3.2-2 shows, for example, that in the common pickup/dropoff mode, 1.29 vehicle trips are generated for each one-way air passenger trip. For the drive/park mode, only .74 vehicle trips are generated per air passenger trip.

In a region with significant Clean Air Act attainment problems, planners must expect to use a full calculation of regional VMT change as a principal performance measure for the evaluation of projects, strategies, and actions under consideration.

The use of regional VMT does involve, however, a relatively cumbersome process of modeling to have much validity. Massport policy analysts were seeking a shortcut measure with which to rapidly review a wide variety of policy options. The most effective of these quick-turnaround methods is the use of the basic performance measure *vehicle trips per passenger trip*. In this innovative evaluation method, any policy action that has the effect of moving the passenger to a lower ranking on the levels shown in table 3.2-2 is considered to be positive. Any policy action that has the effect of moving the passenger up the list is considered to be negative. In the world of developing multimodal planning techniques, this method is exemplary in that it is "modally blind" and can be applied to a wide variety of possible policy interventions.

Table 3.2-2. Ground Access Vehicle Trips Per Air Passenger Trip[3]

Mode	VT/PT
Pickup/Dropoff	1.29
Taxi	1.09
Parking	.74
Rental Car	.69
Door-to-Door Shuttle	.33
Scheduled Bus	.10
Rapid Transit	0

An investment in a rail transit facility, for example, can be compared with the alteration of a parking pricing policy, using the same metric of evaluation. With the use of appropriate elasticity factors, policy options that attempt to bring about change in travel behavior in the private auto mode can be compared with options that attempt to move the passenger away from private to public modes.

The policy implications of the data in table 3.2-2 are extremely important. The data show that influencing modal choices in the auto mode must be part of a comprehensive access strategy, in addition to the traditional study of shifting passengers from automobiles to transit. Table 3.2-2 shows that, for every 100 air passenger trips shifting from bus to rapid transit would decrease vehicle trips by 10. Looking at an entirely different kind of policy initiative, moving 100 passengers from dropoff mode to park-alone mode would decrease vehicle trips by 55. (Similarly, moving 100 passengers from taxi to door-to-door shuttle would decrease vehicle trips by 41). This analysis led Massport policy planners to focus their attention on the role of parking supply and parking pricing in an effort to deal with the serious problem of the pickup/dropoff trip. The analysis suggested that it would be cost effective to invest in a major advertising campaign to discourage the pickup/dropoff trip.

For regions that do not have to examine a wide variety of policies to deal with congestion and air quality issues, the performance measure *vehicle trips per passenger* trip may require a more detailed level of analysis than is warranted. However, for airports and regions where the cost-effective analysis of a wide variety of strategies is mandated, the use of Massport's new performance evaluation metric can provide the policy-maker with a sense of how candidate strategies may affect separate market segments, and of the likelihood of their success.

3.3 Airport Ground Access Performance Measures at the Facility Level

In this chapter of the guide, experiences with performance measurement for airport ground access have been reviewed. It is important at this juncture to emphasize the fact that the science, or the art, of performance measurement in a specialized field, such as airport ground access, is in its infancy. Thus, it is reasonable to explore what could be considered the basic essential measures to be used in the early years of application of performance measurement. This chapter of the guide concludes with a review of some of the basic information appropriate for performance measurement of airport ground access. A short list of basic data elements for inclusion in performance evaluation is presented and summarized in table 3.3-1.

1. *LOS on Connecting Link.* The most commonly used measure of the quality of airport access, and perhaps the first element of data to be collected is LOS on the access road between a hub airport and the major expressway system. The LOS on that road (or collection of roads) often serves as an early warning system for other, more difficult to measure aspects of airport ground access quality. For those systems with dedicated right-of-way transit, similar observations can be made about the quality of service on the transit facilities, as well.

2. *Quality of Condition on Connecting Link.* Distinct from the performance of the transportation system over the road, is the question of the physical quality of the facility itself. Substandard curves, radii, or structural conditions can signal major issues that must be addressed. In addition, many areas are concerned about the general aesthetic conditions of the connection between the airport and the major

areas served. It is common to call for a "parkway." For those American airports with dedicated right-of-way transit, this category would include a review of the conditions of that facility.

3. *Choices for Access.* After the basic characteristics of the connecting links are observed, the next question concerns the existence of a variety of modes to provide services. Is there taxi service? Is there guaranteed taxi service for each airplane arrival? Are there rental cars? Is pedestrian access good? Can the facility be accessed by bicycle? Are there limousines? Is there connection to the local public transportation system, e.g., a local bus? Before the issues of quality of service and use of separate modes are raised, this inventory of options can be very effective in analyzing deficiencies.

4. *Quality of Non-SOV Service Options.* Having undertaken the inventory of ground access service options, the next questions concern the adequacy of those services. Are limousines available to major destinations every hour or less? Are shared-ride services available with less than a half-hour wait to form the group? Do taxi regulations insist on clean, well-maintained vehicles? Do illegal operators form a threat to public safety?

5. *Mode Split to Non-SOV Service Options.* Over time, the quickest and most statistically relevant manner in which to observe the success or failure of airport access services as part of regional transportation policy is careful tracking of the mode splits for all access modes. This implies the implementation of a regular program of surveying — every 2 or 5 years, for example. The survey can then be updated by anecdotal observation of changes in volumes of any particular mode; however, it is essential that a systematic effort be undertaken on a predefined interval to have a statistically valid basis for observation.

6. *Air Quality/Congestion Relief Characteristics of Access.* For airports located in areas found to be in nonattainment of Clean Air Act compliance, the simple observation of modes used may not be adequate to support necessary documentation and analysis. Performance indices may need to be created that record the actual occupancy of airport users for each mode, as well as rudimentary measures of the air-pollution-generating characteristics of the vehicle itself. Thus, a 40-passenger bus carrying 5 persons may show poorer performance that an 8-passenger van carrying 4 passengers. Also, the monitoring system should pay particular attention to the problem of pickup/dropoff trips, which have exceptionally negative VMT implications. The level of detail required for this analysis will be determined in the environmental scoping process with the relevant air quality agencies; attention should be directed to the use of cost-effective surrogates to the full-scale air

quality modeling process. Massport's performance measure, *vehicle trips per passenger trip,* is an example of a measure designed to evaluate congestion relief strategies.

7. *Safety*. In this area, it is possible to spend valuable, scarce resources organizing data that most logically belong in other jurisdictions, including the safety management plan. However, to the extent that data organized by others reveal statistically significant patterns, or to the extent that user surveys reveal that perceptions of unsafe conditions are affecting travel patterns, safety characteristics should be noted in the overall review of the quality of airport access services. Examples include the inadequate regulation and supervision of taxi and limousine services, which might be particularly relevant at airports, because people with no knowledge of the area are being served.

8. *Public Information/Information Systems/Community Acceptance*. Community perceptions of conditions and services play a major role in influencing travel behavior. At the facility level, a survey of the adequacy of information systems describing ground access will make possible an assessment of the performance of the system in terms of information and direction. At the community level, a quick review of activities can determine the extent to which business and community leaders are involved in encouraging high-quality access to the local airport facility as a function of civic pride. At the neighborhood level, it should be determined if communities affected by vehicles going to and from the airport are aware of, or involved in, efforts to minimize the external impact of successful airport operations.

Table 3.3-1. Performance Measures at the Facility Level: A Startup List

Policy Concern	Performance Measure	Data Source
Quality of service on access facility	LOS V/C crowding conditions on transit, if relevant	Seasonal traffic counts Seasonal ridership counts Basic capacity data
Condition of access facility	Structural condition Design standards Ride quality	Maintenance records Field examinations
Existence of choices for ground access	Number of modes, by functional category	Schedules Operating agreements Permits, etc.
Quality of non-SOV services	Headways Waiting times Vehicle cleanliness Quality	Inspections User surveys Application of service standards
Mode split to non-SOV modes	Percentage of total airport users gaining access to airport via shared-ride services	User surveys, updated with mode-specific ridership reports
Role in air quality, congestion relief strategies	Total VMT from airport ground access Surrogate calculations for total emissions	Trip length data, by mode Emissions, by mode
Public safety	Statistically valid patterns Community concerns	Police records Accident statistics
Public information, information systems, community acceptance	Adequacy of signs Public information on modes Community involvement	Canvass of facilities Inventory of services available

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CHAPTER 4

DATA COLLECTION AND SURVEYS

4.1 Establishing Data Needs

This chapter describes techniques available to obtain data related to different airport ground access goals, objectives, and performance measures. Airport access data could include a base-year inventory consisting of surveys of physical and operational characteristics of intermodal facilities and systems based on performance measures. Additionally, access data may include the number of arriving passengers, number of vehicles entering on-airport parking lots, and number of persons using transit and other modes of travel to the airport. Data collection is just one of several steps in conducting an airport survey, shown in figure 4.1-1. In addition to airport access surveys, these steps can be used for other types of surveys, including traffic studies and employee surveys. Figure 4.1-1 shows that the first step in creating an airport access study is to define study objectives. This step was discussed in Chapter 2 of this guide. The remaining steps, identify data requirements, select survey strategy, select data collection techniques, prepare survey specifications and conduct survey, and summarize post-survey findings, are discussed in the following sections of this chapter. Additional information on the survey selection process can be found in the FHWA *Airport Travel Survey Manual.*[1]

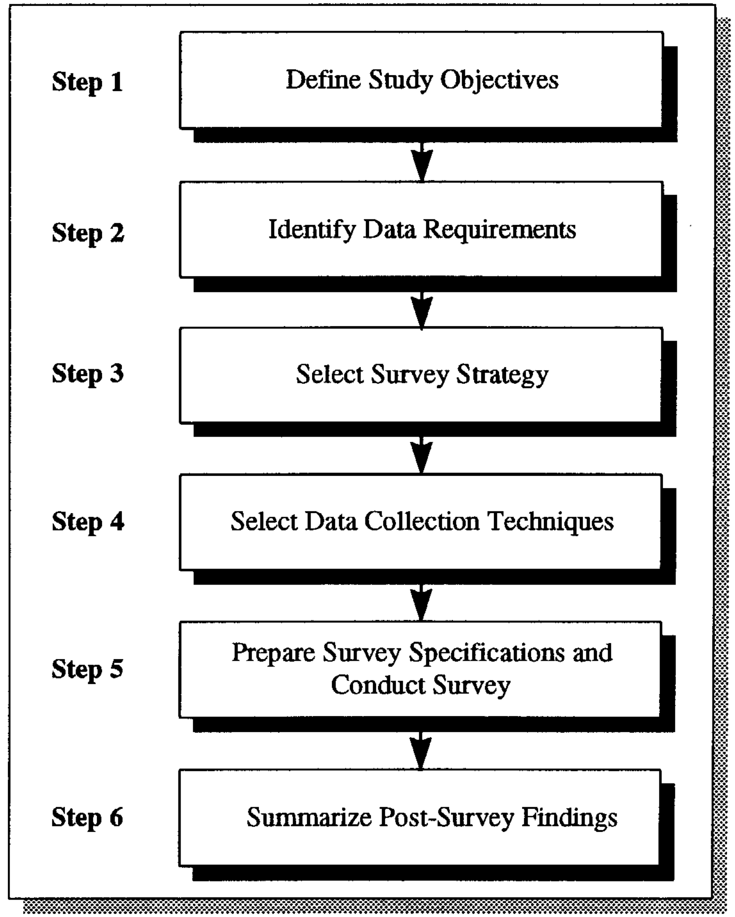

Figure 4.1-1. Steps in Creation of Airport Access Survey

4.2 Identify Data Needed To Quantify Performance Measures (Step Two)

Table 4.2-1 provides an example of goals, objectives, and performance measures that can be used to define airport ground access issues. Goals are broad statements of desired achievements, objectives are the desired outcomes of the goals, and performance measures are quantifiable methods of achieving the objectives. Each objective must have at least one performance measure. For example, in table 4.2-1, the first goal is to improve accessibility to the airport. Two objectives of this goal are to: (1) minimize travel time to the airport and (2) provide peak capacity. The first objective, to minimize travel time, may be measured by collecting travel times between selected points to determine how long it takes to get from point A to point B. When a decrease in travel time can be measured, progress toward the objective has been achieved. The second objective, to provide peak capacity, may be measured by gathering LOS data at peak periods. As LOS improves, progress toward the objective has been achieved.

4.3 Select Survey Strategies (Step Three)

Selecting survey strategies involves choosing the most appropriate type of survey and the place to conduct it. Surveys may be conducted in many locations, depending on the purpose of the survey and the results needed. For example, surveys can be conducted at intra-airport terminal points, such as curbside dropoff or transit stations (for data on ground access or nonprivate automobile users), at roadside survey stations, or at the entrances or exits of airport parking garages (for data on private automobile users). If data are to be collected on air travelers, as well as visitors accompanying air travelers to the airport, interviews should be conducted at places of activity, such as a terminal boarding area or ticket counter where passengers and visitors congregate before their flights.

4.4 Data Collection Techniques (Step Four)

Table 4.4-1 describes representative survey techniques that can be used to collect data for each of the sample performance measures. The important factor is deciding what type of study or survey to use. As shown in the table, some data collection techniques can be used for only a few performance measures and some apply to the majority of them. There are three principal factors to be considered in the selection of survey techniques: (1) the type of study being conducted, which controls the types of information and levels of accuracy required, (2) activity level at the airport under study, which is measured by the size of the population or subgroups (such as air passenger transit riders) to be surveyed, and (3) the configuration or spatial arrangement of activities of the airport under study.

There are many different types of surveys and studies that can be used for obtaining airport ground access data. Each type uses different methods for obtaining the desired data, and each is used for collecting different types of data. The best approach is to determine what data are required and which type of collection technique will produce the most appropriate results.

Table 4.2-1. Sample Goals, Objectives, and Performance Measures for Airport Access Systems

Goals	Objectives	Performance Measures
1. Improve accessibility to airport.	1a. Minimize travel time.	Travel times between selected points by different access modes
	1b. Provide peak capacity.	Extent of vehicle queuing and overall system delay LOS at peak periods
2. Improve connectivity between transportation modes.	2a. Improve access and transfer between modes.	Parking spaces per passenger Loading area per passenger Time and distance of transfer between modes less than *X* feet and *X* minutes
	2b. Connect major routes to local modes.	Service availability and layover times between modes
	2c. Improve on-time performance at terminals.	Percent of surface transport departures outside of 15-minute schedule
3. Maximize flexibility of system for users.	3a. Improve modal choices for non-SOV users.	Availability of ground access options
	3b. Provide convenient transit.	Availability of remote intermodal ticketing and luggage support
	3c. Promote information on available services.	Level of information dissemination about alternative options
	3d. Provide frequent HOV service.	Number of round trips per service per day
	3e. Make HOV services competitive with cars.	Ratio of travel times
4. Improve safety.	4. Reduce accidents.	Number of accidents Accidents per passenger mile Number of conflict points

Table 4.4-1. Representative Techniques To Collect Data for Sample Measures of Effectiveness (MOEs)

Objectives	MOEs	Collection Techniques					
		Volume	Travel Time and Delay	Inventories	Traffic Conflict	Passenger Survey	Employee Survey
1a. Minimize travel time.	Travel times between selected points		●		●		
	LOS at peak periods	●	●				
1b. Provide peak capacity.	Extent of vehicle queuing and overall system delay	●	●				
2a. Improve intermodal access.	Parking space per passenger			●		●	●
	Loading area per passenger			●			
	Time and distance of transfer mode		●	●		●	●
2b. Improve connectivity.	Service availability and layover times between modes		●	●		●	●
2c. Improve on-time performance.	Percent of surface transport departures outside schedule		●	●		●	●
3a. Improve modal choices.	Availability of ground access options			●		●	●
3b. Provide convenient transit.	Availability of remote intermodal checking and luggage support			●		●	
3c. Promote information on available services.	Level of information disseminated about alternative options			●		●	●
3d. Provide frequent HOV services.	Number of round trips per service per day			●			
3e. Make HOV competitive with SOV.	Ratio of travel times		●	●		●	●
4. Reduce accidents.	Number of accidents				●		
	Number of accidents per passenger mile				●		
	Number of conflict points				●		

There are generally three broad types of surveys and studies that can be conducted: traffic, passenger, and special purpose. These different types of surveys and studies are discussed in this section.

Traffic Studies

Basic traffic studies are used to collect data related to traffic conditions, patterns, movement, characteristics, trends, etc., and are performed to gather information on the physical characteristics and movement patterns of the airport ground access system. These studies may provide data on specific airport access issues, such as congestion at curbside caused by taxi backups, or number of cars that enter a parking facility and subsequent delay caused by backups at the entrance and exit booths. Traffic studies may also be conducted to assess the overall congestion and flow of the airport road network or any number of traffic-related issues. Traffic data may be needed in addition to passenger and employee data to provide a comprehensive study of traffic and passenger trends and characteristics of airports.

Several types of traffic studies that can be used to analyze airport ground access performance are briefly discussed below. A more thorough discussion of traffic studies can be found in the Institute of Transportation Engineers (ITE's) *Manual of Transportation Engineering Studies.*[2]

Volume studies can be manual or automatic tabulations of objects, people, or occurrences. These could include, for example, the number of vehicle turning movements at entrance and exit points to an airport or different classifications of ground access modes serving an airport. The data collection period may vary depending on the type of data to be collected, and may range from hours to days, weeks, or even months. Further information on volume studies may be obtained from Chapter 2 of the *ITE Manual.*

Travel time and delay studies measure the performance of the road network. Travel time and delay studies can be performed to determine the quality of traffic flow within the airport access road network. For example, travel time studies may be used to determine how long it takes to get from the entrance to the exit of the airport terminal frontage road. The longer it takes, the more congestion the network is experiencing. These studies may be used for any form of ground access and may be particularly useful in tracking how long it takes HOV modes, such as an on-airport shuttle van, to make a complete loop through the curbside areas. The different types of travel time and delay studies are: moving vehicle, license plate, direct observation, and interview studies, each using different techniques. Further information on travel time and delay studies may be obtained from Chapter 4 of the *ITE Manual.*

An example of a license plate travel time and delay study dealing with airport access was a study conducted at a major domestic airport. License plate numbers were recorded as taxis entered and exited the taxi parking structure (TPS) to determine their dwell times in the TPS facility. This critical data element was needed to evaluate options for changing the operation and/or capacity of the facility.

Inventories are tabulations or listings of records and data of existing conditions. They may be compiled for virtually any need and are typically used to count the actual number of something, such as the number of ground access modes that serve an airport, the number of users of a specific ground access mode, or the number of parking spaces at an airport parking facility. For example, a parking space inventory was conducted at a major domestic airport where all legal employee parking spaces were identified and inventoried by type (i.e., air crew, handicapped, etc.) for the purpose of identifying deficiencies and needs for alternative ground access options.

Another example of an inventory related to an airport access study was an analysis conducted to create a ground access system for a small international airport. The first step of the project involved conducting an inventory of all nonautomotive modes currently serving the airport, including taxis, limousines, buses, and charter vans and buses, to assess existing conditions. Further information on inventory studies may be obtained in Chapter 6 of the *ITE Manual*.

Traffic conflict studies are used to gather information on incidents that occur between two or more vehicles or other road users, such as pedestrians. Conflicts occur when the drivers of one or more vehicles have to take evasive action, such as slamming on the brakes or weaving to avoid impact. This type of study may also be used in an airport ground access study to identify conflict points, such as at crosswalks or curbside at terminals, where pedestrians must interact with vehicles. Vehicle-to-vehicle conflicts may occur curbside, as vehicles are constantly pulling into and out of dropoff areas to dropoff and pickup passengers. If there are points where conflicts occur, accident data on the location and conditions at the time of the accident may be used to help create countermeasures that will decrease the hazards of the conflict point. Further information on traffic conflict studies may be obtained in Chapter 12 of the *ITE Manual*.

Passenger Surveys

These types of surveys are conducted to compile information about travel patterns and user characteristics of air travelers. Air passenger surveys help quantify airport travel patterns, including use of existing facilities, LOS provided to airport users, and the relationships between current travel demands and airport activity levels. Typical data collected in air passenger surveys include demographic characteristics, travel patterns and preferences, origin-destination information, frequency of usage of both airports and modes of travel to the airport, and reasons for the use of one access mode over another. These data are used primarily for planning future ground access, and airport and airline facilities and services. Air passenger surveys can be used to project travel demands for ground transportation facilities as they relate to anticipated growth in airport activity. These studies can also be used to evaluate alternative transportation system improvements designed to serve projected travel demands. Air passenger survey questions can be customized to address the desired information requirements.

In the fall of 1995, an airport passenger survey was conducted at a small international airport. The purpose of conducting this survey was to determine the most effective airport ground access plan that would decrease the use of SOV to the airport. This information was determined by collecting data on the number of resident and visitor travelers using the airport and their methods of arrival to the airport, as well as other data, to estimate the current and future enplanements at the airport.[3] Further information on airport passenger surveys may be obtained from the FHWA *Airport Travel Survey Manual* and the more detailed discussion later in this chapter.

Special-Purpose Surveys

Generally, any type of survey or study that is not traffic- or air-passenger-related can be categorized as "special purpose." These studies can be conducted for many purposes. For example, a special-purpose survey was conducted for a major domestic airport dealing with congestion caused by taxis. Taxi system managers and ground transportation managers from other large airports with high taxi use were interviewed to ascertain how their airports dealt with taxi issues, such as permits, parking, queuing, and overall management. This survey provided information useful for developing a taxi management system for the airport with the problem.[4]

Employee Surveys

Another example of a special-purpose survey is an employee survey, which can be conducted at an airport to capture demographic characteristics and commuting patterns of those who work for a specific employer (such as an airline) or within an airport itself. These surveys determine origins and destinations of employees, modes of travel taken to and from work, and other relevant employee information. Similar to passenger survey results, employee survey results can be useful in planning for future ground access, and airline and airport facility improvements and services.

4.5 Survey Design (Step Five)

During this phase of the survey process, the survey type to be used for collection of travel data is selected, and the survey questions to be asked are determined.

Traffic Studies

This section briefly describes how the different traffic studies are conducted. Detailed discussions of how to conduct traffic studies are provided in the *ITE Manual*. The different types of traffic studies are typically conducted in one of two ways. Most often, data collection for traffic studies involves counting, either manually or by an automatic counter, the number of vehicles, persons, or other data elements being studied. Manual methods of data collection may vary somewhat, but most rely on a person's observations. Automatic methods of data collection require the use of counting equipment, such as tubes or sensors, which do the actual counting.

Volume studies may be performed either manually or automatically. Manual counting requires observation at the vantage point where all traffic activity at the study site can be seen clearly. Automatic counting, on the other hand, relies on specialized equipment to do the actual counting, while personnel are required to install and retrieve the equipment and download the data from the counter to the computer.

Travel time and delay studies may also be performed either manually or automatically. Manual data collection requires a person to drive a test vehicle while another person observes and records travel times as the study area is traversed. Automatic data collection requires equipment that is connected to the test car and can be operated by the driver, eliminating the need for the additional observer or recorder. Both manual and automatic data collection require conducting several travel runs to obtain a representative average vehicle travel time.

Inventories are performed by direct observation. They are most often stored on computer files and data bases but may also be stored in hard copy forms, such as bound lists, maps, folders, or microfiche. The method of storage must be matched to the frequency of use; the more the data are used, the more important it is to have a data base that allows easy retrieval.

Traffic conflict studies rely on the observation of brake lights and squealing tires to indicate that a conflict has occurred. Problem areas — either at intersections or on sections of roadway — are observed for several days to gain accurate data to aid in estimating the traffic accident potential.

Passenger Survey Methods

A major reason for conducting airport passenger surveys is to identify and measure the ground access travel patterns of air travelers. Quite often, air passenger surveys are also conducted to analyze ground transportation used. It is important to differentiate the categories of airport users ,air passengers, airport employees, and airport visitors, because each group has different travel characteristics and needs. The unique characteristics of airport travel patterns for each category of airport user need to be understood. For example, in many cities, nonresident air travelers make up the majority of airport users. In terms of ground transportation, nonresidents tend to be more unfamiliar with the options available to them and tend to rely on taxis and rental cars as their preferred modes of transportation.

There are four methods that can be used for air passenger surveys: personal interviews, self-administered surveys in waiting areas, self-administered surveys onboard airplanes, and mail-back surveys.

Once it is determined that an air passenger survey will be conducted, an appropriate method will need to be determined.

Personal Interview Method

In this technique, survey personnel ask questions directly of respondents, recording answers on a prepared form. This type of survey requires that the respondent not be pressed for time or that only a few questions are asked. Personal interviewing is most applicable when certain aspects of the questionnaire might not be understood by the respondents or when the line of questioning followed is dependent on the response to specific questions. Personal interviewing is also advantageous when a screening process is performed as part of the field survey, such as questioning persons who do not appear to be airline passengers (i.e., those who are not carrying any luggage) to determine whether they are passengers, travel-related visitors, or visitors with some other purpose. The principal disadvantages of the personal interviewing technique are the possibility of interview bias and the high cost per sample collected in comparison to other data collection techniques.

Self-Administered Method — Distributed and Collected in

Waiting Areas

This survey technique is a self-administered questionnaire that is distributed to respondents in the waiting area before boarding an airplane. Respondents are handed a questionnaire to be completed, and survey personnel collect completed questionnaires after a reasonable time period. For this technique to be applied successfully, the respondent must not be pressed for time and the questionnaire must be simple, in the sense that questions may be easily understood by respondents. It is also important that at the time of completing the questionnaire, the respondent knows the answers to questions asked, rather than having to guess, predict, or estimate his or her responses.

Self-Administered Method — Distributed and Collected Onboard Airplanes

This technique also uses a self-administered questionnaire, but one that is distributed to passengers once they have boarded the airplane. This is similar to the previous type in that the respondents answer the survey questions at their own pace. The obvious difference is that this method distributes surveys while in flight, as opposed to in the preboarding area. A survey distributed by this method can be longer, because the passenger is "captive" and has more time to fill it out. It is important to have a high level of cooperation from the airline to conduct this type of survey, because airline personnel will be responsible for distributing and collecting the survey and answering any questions that respondents might have.

Mail-Back Method

A fourth survey technique is a self-administered questionnaire that is distributed to respondents to be filled out and mailed back to the survey office. This technique is most applicable when the respondent will not be able to answer certain questions until leaving the airport. The success of this technique is highly dependent on the use of a simple, readily understood questionnaire. The questionnaires are pre-addressed and have prepaid postage to make it easy for respondents to mail them back. Even so, this method generally has the worst response rate, because completion and return of the questionnaire is voluntary.

Because the majority of surveys take place on airport property, it is absolutely imperative that permission to conduct the passenger surveys be granted by airport and airline management. It is also important that all airline personnel be made aware of the survey, so they can provide help in making passengers aware of the need to respond to the survey. For example, during the Washington-Baltimore Regional Air Survey, survey personnel distributed surveys to respondents and airline personnel made periodic announcements over the intercom to ask respondents, to help by participating in the surveys.

Table 4.5-1 identifies survey methods by type of individual surveyed, airport characteristics, and types of surveys that should be conducted, depending on the level of annual enplanements at the airport and the group from which data are needed. Most small- and medium-hub facilities contain only a single structure to accommodate passenger check ins, ticket sales, baggage pickup areas, and ancillary airport services used by airline passengers and airport visitors. This concentration of activities tends to channel airline passengers and airport visitors departing via any transportation mode to a small number of curbside loading and unloading zones. At this point, surveys may be conducted, because the number of access points is limited. As the activity level and size of the airport increase, the number of survey personnel required increases, and it becomes more difficult to account for all passengers.

Passenger Survey Design

Once it has been determined what information and data are needed from survey results, survey questions are created that make it possible to obtain them. Because space on the questionnaire form and respondent patience may be limited, questions should be designed very carefully and restricted to those to which answers are needed for the analysis. Proper questionnaire design should be preceded by a mock analysis to simulate the final analysis.

Starting with the variables known to be needed for analysis, suitable fictitious data should be used and the analysis process should be run through. Frequently, this will generate awareness of additional variables that are needed to complete the analysis.

Table 4.5-1. Survey Method by Population Category and Airport Characteristics

	Low Activity Level, Concentrated Activities, Minimal Public Mode Use	Moderate Activity Level, Concentrated Activities, Minimal Public Mode Use	High Activity Level, Dispersed Activities, Minimal Public Mode Use	High Activity Level, Concentrated or Dispersed Activities, Extensive Public Mode Use
Air Passengers	Personal interview* Collected questionnaire	Personal interview* Collected questionnaire Mail-back questionnaire	Collected questionnaire* Mail-back questionnaire	Collected questionnaire* Mail-back questionnaire*
Airport Visitors	Personal interview* Mail-back questionnaire	Personal interview* Mail-back questionnaire	Mail-back questionnaire	Mail-back questionnaire
Employees	Collected questionnaire	Collected questionnaire	Collected questionnaire	Collected questionnaire

* Asterisks indicate generally preferred techniques.

Once all the variables to be gathered by survey are listed, the questions must be formulated to measure them. Every question should include a null option, because ambiguity will arise if the respondents do not answer and a nonanswer can be interpreted to mean something different from a null option. Questions should always be worded clearly and precisely, forgoing vague terms in favor of specific. Each question on the questionnaire should be numbered, and each questionnaire should have a serial number.

Closed-ended categorical questions will generally form the bulk of the questionnaire, and checkoff boxes that guide answers into distinct categories are generally the norm, because they are easier to interpret in analysis. It is important that categories do not overlap to minimize ambiguity. If a survey is to be filled out by a representative of a group, it is helpful to ask the number of people in the group and to ask the representative to fill out separate surveys if any of the other group members' answers would differ from the group representative's. Open- ended — or "fill-in-the-blank" — answers should be kept to a minimum. It is helpful to label different sections as they relate to different types of questions, e.g., "about your journey to the airport" or "about yourself."

In any of these questions, it is important to define "people" in terms of age. Are children included? Are infants? If not, what are the cutoff points? It is also important that the tenses of the verbs in the questions are correct for all respondents; otherwise, there may be considerable confusion. This usually means that separate questionnaires must be prepared for arriving and departing passengers.

Unstructured answers should be solicited only if suitable, as in cases where the surveyor feels the response will be biased if alternative answers in checkbox form are provided. Along these same lines, if a list of items is provided on an attitudinal question, the order of the list should be reversed on one-half of the surveys to help eliminate any bias that might be introduced by always having the items appear in the same order.

In general, all that is needed in question design is thoughtful analysis of the different interpretations that people may make of the required responses. Pretesting the questionnaire on a variety of people with different interpretive skills is the most effective way of finding and eliminating ambiguities. Pretesting several times is essential, even though at first sight it may seem unnecessary. All survey questionnaires, particularly the mail-back type, must include a brief description of the aims and authorship of the survey. It is important that this introduction be neutral, so that it will not bias the respondent. Particular attention should be paid to the layout and spacing to make it attractive to the respondents. It is particularly important to add serial numbers, because the cards must be sorted during analysis and because they are critical for determining the appropriate expansion factors.

To reduce the occurrence of survey bias, it is important to select a large enough sample that includes both air travelers and visitors accompanying them. It is also important that both peak and nonpeak periods during the week and weekend are sampled, because trip purposes differ during these times. The survey should occur over a period of several days, so that a random sample of flights each day can be surveyed and not the same flights each day.

An example of an air passenger survey questionnaire, used for three airports serving the Washington-Baltimore area, is included in Appendix A.[5] The *Washington-Baltimore Regional Air Passenger Survey* was conducted to determine local airport needs. Three other examples of passenger survey method questionnaires are also in Appendix A. These include examples of a basic self-administered collection questionnaire, a basic mail-back questionnaire, and a basic personal interview questionnaire for airport visitors who are not traveling. Other examples of air passenger surveys from the *Port Authority of New York and New Jersey Air Passenger Survey, 1993,*[6] and *Atlantic City International Air Passenger Survey*[3] are also illustrated in Appendix A. Additional information on training surveyors on the proper interviewing techniques is provided in the *FHWA Travel Survey Manual.*

4.6 Processing of Survey Data (Step Six)

Interpreting post-survey findings involves processing the survey data by editing forms, coding travel information, expanding samples, performing accuracy and completeness checks, and preparing analysis tabulations. Coding travel information from passenger origin-destination (O-D) surveys, usually by traffic or district zone or by zip code, makes it easy to determine the origins of respondents' trips. Trip origins and destinations are the most difficult types of information to code. For areas in which a regional transportation study has been conducted, traffic zones or districts will have been defined and should be used if at all possible. The two most common coding devices are maps (on which the street system and address numbering system are overlaid by lines showing the boundaries of traffic zones or districts) and address coding guides (lists of street names and number ranges, along with the corresponding traffic zone or district number). Use of either of these coding devices requires that the tripmaker record a specific address for the trip origin or destination, so that survey personnel may code the appropriate zone or district number on the completed survey form. When airport travel data are collected as input to an airport access study that does not require the precise location of the trip origin, postal zip codes might be used as the basis for this coding system. This offers the advantage of a ready-made coding guide, and the respondent can record the zip code number directly on the survey form. Because a good number of air passengers and airport employees are residents of the metropolitan area in which the airport is located, it is reasonable to assume that they would know the zip codes of their origins.

Expansion of the survey data will be required whenever a sample, rather than a census, of tripmakers is taken. Factoring might even be necessary for a census, if a significant number of refusals or unusable survey records is encountered. Separate expansion factors should be determined for each of the surveys conducted in a single study. The expansion factor is equal to the ratio of the total number of persons on each flight to the number of survey records obtained for that category.

Expansion of the sample must also take into account trips that are double-reported. For example, when a survey of users of short-term parking facilities is conducted in addition to an air passenger survey, it is likely that a number of air passengers parked in short-term facilities or were dropped off by visitors who parked there. Based on the coding of population categories and modes used, replicated travel data should be deleted from one or the other of the data sources.

Questions That Should Be Included in an Airport Passenger Survey

- Where did you begin your trip today (address, zip code)?
- Was this a residence, hotel, work, other?
- What is your age?
- How did you arrive at the airport?
  - Private car
    - Did you drive yourself and park?
    - Were you a passenger and dropped off curbside?
    - If you were a passenger, was the driver also an air passenger?
  - Rental car
  - Taxi
  - Door-to-door van
  - Shared limo (more than one travel party)
  - Private limo (one travel party)
  - Bus
  - Rail
  - Courtesy vehicle
- What was the purpose of your trip: recreation, work, personal/emergency?
- Please indicate your current residence: (city/county, state, zip code, country)
- How many bags did you check for this flight?
- Did any members of your household, friends, or business associates accompany you to the airport? How many persons accompanying you actually traveled with you?

Precise determination of the expansion factors is important. Expansion factors of an air passenger survey in which samples are selected from certain flights over a period of several days or weeks might be determined by hourly periods, based on a comparison of the number of survey records collected and total air passenger originations at the airport during these hourly periods. An alternative expansion technique would be to aggregate samples for days representing midweek conditions and for days representing weekend or holiday conditions. A set of hourly expansion factors could then be based on the comparison of the survey records obtained and total passenger movements by hourly period in each of these two major categories. This expansion technique assumes that travel patterns are similar for each of the midweek days of the survey period and for weekends or holidays, with significant differences between the two categories.

Another method of expanding survey results to obtain an estimate of airport use is by flight rather than by passenger. This was the chosen method for expansion of survey results from a survey conducted at a small international airport.[3] The survey responses for each flight were factored by total boardings for each flight to represent all passengers on a surveyed flight. The total number of passengers on a flight was divided by the number of surveys actually completed by passengers on that flight. In this way, boarding factors specific to each flight were applied to each survey response.

A common use of the findings of an air passenger survey is to estimate the use of various ground transportation modes. Results may be validated by comparing these findings to grouped counts. For example, the number of persons arriving by taxi, according to an air passenger survey, can be compared with the number of taxi movements derived from dispatcher records. The comparison of expanded survey findings with independent counts of mode use may also be used to determine the impact of tripmakers not surveyed. At larger airports, a mixed survey strategy is recommended, in which air passengers, airport employees, and users of the primary visitor modes (e.g.,short-term parking facilities and regularly scheduled bus and rapid transit services) are sampled. These data sources may be combined to estimate the number of movements by mode and by hourly period. Discrepancies between surveyed travel patterns and actual counts of traffic by mode may be attributed to nontraveling visitors using modes not specifically surveyed.

Tabulations of the expanded survey data depend on the specific analysis techniques used. Typical tabulations often required for airport access studies are shown in table 4.6-1. Typical tabulations for airport access analysis include mode of transportation to the airport by passenger origin, time, socioeconomic characteristics, group size, number of bags checked, purpose, visitor or resident status, and age. Depending on the question asked in the survey, the possibilities for tabulations of the data are numerous. Additional guidance and instruction on expanding samples can be found in Chapter 5 and Appendix B of the FHWA *Airport Travel Survey Manual*.

Both peak day and average day conditions are important to the design of ground transportation facilities and services. Peak day travel demands must be analyzed to ensure that acceptable LOS will be provided under the maximum anticipated loading conditions. To evaluate the economic feasibility of a ground access system, however, it may be more appropriate to analyze average demands for the facility under study. As previously suggested, it is wise to survey air passengers and airport visitors over an extended period; at a minimum, travel data should be collected for a midweek day and a Sunday or holiday. The mix of air passengers by trip purpose will vary significantly for these two periods, and the number of travel-related visitors will show a corresponding variation. Consequently, certain tabulations (mode by origin and mode by time of day) should be made separately for these two periods.

As shown in table 4.6-1, tabulations of air passenger travel patterns should be prepared separately for passengers traveling for business purposes and for other trip purposes. This facilitates the derivation of factors relating the survey period to other seasons of the year and the projections of demands for ground transportation services associated with forecasted airport activity levels. Seasonal variations in air passenger traffic are primarily a result of the greater number of nonbusiness trips made in vacation periods. Also, long-term growth in air passenger traffic is partially attributable to the greater use of airlines for nonbusiness travel associated with long-term increases in disposable income.

Table 4.6-1. Typical Survey Tabulations by Population Categories

Population Categories				
Employees	**Air Passengers**		**Visitors**	
	Business	**Personal**	**Travel-Related**	**Other**
1. Mode by O-D	1. Mode by O-D by day	1. Mode by O-D by day	1. Mode by O-D by day	1. Mode by O-D by day
2. Mode by time	2. Mode by time by day	2. Mode by time by day	2. Mode by time by day	2. Mode by time by day
3. Mode by socioeconomic characteristics	3. Mode by socioeconomic characteristics	3. Mode by socioeconomic characteristics	3. Mode by socioeconomic characteristics	3. Mode by socioeconomic characteristics
4. Mode by employee classification	4. Mode by lead time	4. Mode by lead time	4. Mode by lead time	4. Mode by purpose by day
5. Specific parking area used	5. Mode by travel-related visitors	5. Mode by travel-related visitors	5. Mode by passenger's trip purpose	5. Purpose by time by day
6. Midday use of terminal roadways	6. Mode by trip duration	6. Mode by trip duration	6. Mode by passenger's trip duration	
7. Midday use of terminal shuttle services	7. Mode by group size	7. Mode by group size	7. Intra-airport circulation by time	
	8. Mode by bags checked	8. Mode by bags checked		
	9. Intra-airport circulation by time	9. Intra-airport circulation by time		
	10. Interline transfers by O-D by mode	10. Interline transfers by O-D by mode		
	11. Interline transfers by lead time	11. Interline transfers by lead time		
		12. Purpose by time by day		
		13. Interline transfers by purpose		

Certain of the typical tabulations listed in table 4.6-1 are unique to the description of airport travel patterns. Information on the number of bags checked, for example, may be critical for the design of shuttle services between remote parking areas and terminal buildings. A substantial amount of intra-airport circulation may be expected, in which private autos use curbside loading or unloading zones before or after parking in airport facilities. The term "lead time" refers to the amount of time before scheduled flight departures allowed by air passengers or the time allowed by travel-related visitors before scheduled flight arrivals for waiting at terminal facilities for deplaning passengers. Lead time will, of course, be correlated with parking duration for travel-related visitors and will also contribute to the lag between peak time for demands on ground transportation services and peak air passenger movements.

Tabulations for traffic studies are performed differently than those for passenger surveys. The analysis of traffic studies depends on the type of study being conducted. For example, volume study data will be different from travel-time and delay study data, and the methods of analysis and reductions will differ. For guidance on procedures and methods for data reduction of volume study data, see Chapter 2 and Appendix C in the *ITE Manual*. For methods and procedures for data reduction of travel-time and delay study data, see Chapter 4 and Appendix C of the manual. Refer to Chapter 6 and Appendix C of the manual for methods of data reduction of inventories and Chapter 12 and Appendix C for methods of reduction of traffic conflict data.

4.7 Monitoring Provisions

Monitoring travel patterns, after completing a base study of airport travel demands, is essential for identifying unanticipated shifts in mode choice or in the growth of demands for ground transportation services, before these changes critically affect operations. Extensive travel surveys might be conducted at frequent intervals, resulting in a very precise measure of trends in travel patterns, but the costs associated with this approach are prohibitive. Long-term trends may be traced using existing data sources, supplemented by counts and observations, at a comparatively low cost.

The key to efficient use of existing data sources and counts and observations for monitoring travel patterns is relating travel demands to activity levels. For example, long-term trends in the number of airport employee trips may be inferred from data describing the size of the airport labor force. Similarly, the use of ground transportation facilities by air passengers and travel-related visitors may be expected to show a close correspondence to trends in air passenger originations and terminations. Statistics on the size of the airport labor force and the number of air passengers originating and terminating their trip at a particular airport are usually available from existing sources.

Existing data sources may also be used to identify shifts in mode choice. For example, parking lot receipts, bus line revenues, rental car transactions, and similar data sources describing the use of specific modes may be periodically tabulated to identify increase or declines in patronage of the various modes. Periodic summaries of information of this nature are ordinarily submitted to public and quasi-public agencies.

It may be necessary to supplement the information available from existing data sources with counts and observations, or possibly with limited travel surveys, in the event of significant changes in airport activities or ground transportation services provided. Changes in airport activities might include the inauguration of service by an airline not previously operating at the airport, expansion of operations for individual airlines, or establishment of commercial activities not directly related to airlines. Significant changes in ground transportation service might include the major expansion or relocation of airport visitor or employee parking areas, establishment or expansion of a shuttle service, extension of regional rapid transit services to the airport, or expansion or reduction of regularly scheduled bus services.

Counts or observations might be necessary to identify changes in peaking characteristics. Existing data sources cannot ordinarily be stratified in sufficient detail to describe peaking by time of day, although seasonal variations in traffic demands may be derived from these data sources. Counts or observations may also be required to monitor LOS. For example, periodic maximum load point counts might be made for intra-airport shuttle services or regularly scheduled bus or rapid transit services to determine the need for schedule adjustments. The LOS may also be described in terms of travel time along terminal roadways or service time at points of entrance to or exit from parking facilities. Travel times and service times could be determined by periodic observation at critical points of the various facilities during periods of peak traffic flows.

4.8 Employee Surveys

These surveys are conducted similarly to air passenger studies, yet the questions are designed to gather different data to meet different needs. A survey of airport employees could be conducted to gather data on commuting and travel patterns of employees who work at the airport, making sure to separate ground workers from flight crews, because their work schedules and travel patterns differ.

Employee surveys may be conducted to determine what kinds of transit enhancements may be warranted and to analyze the impact of different transit alternatives. Data collected for this type of study include origin (home address in enough detail to permit coding), destination, hours of employment, and mode of transportation to work. Because airports are staffed 24 hours a day, some personnel are required to work nonstandard hours, and this needs to be taken into consideration when analyzing survey data.

Gathering an appropriate employee sample is less affected by daily changes in volumes than gathering an air passenger sample. The number of airport employees broken down by full-time, part-time, and temporary status is needed to have a sufficient control sample for factoring purposes. This way, when expanding employee samples, the total number of employees can be compared to the total number of employees surveyed. More specific employee information that should also be collected includes shift size at different times of the week, employers, and employee classification by type of work and place of work. The relationship between peak and off-peak airport employee travel patterns may be estimated by deriving factors based on the size of peak and off-peak work shifts according to occupational categories, place of work, or employer categories.

The expansion of a sample of airport employees is relatively straightforward. Separate expansion factors might be computed by employer groups and employee classifications within these groups. In the event that sampling rates vary significantly with respect to shift time, this factor might also be considered in the computation of expansion factors.

An example of an employee survey from Boston Logan Airport is provided in Appendix B.

Typical Questions for an Airport Employee Survey:

- Where did you begin your trip?
- Who is your employer?
- What are your hours? What time do you arrive and what time do you depart?
- Do you work in shifts?
- How did you arrive at work? How many people traveled with you?
- If you drove, where did you park?
- How much did it cost to park?

4.9 Statistical Requirements

Information on statistical analysis requirements for air passenger surveys is provided in the *FHWA Airport Travel Survey Manual*. By following proper statistical procedures in data reduction and analysis, inaccurate interpretations of data can be avoided. It is important that properly trained professionals perform the statistical procedures to avoid costly errors. For more information on basic statistical analyses to be use for traffic studies, see Appendix C of the *ITE Manual*. This offers guidance on methods of tabulation, statistical analysis, data summary, and testing of statistical hypotheses, as well as the use of computer programs to perform the analyses.

4.10 Do's and Don'ts

Generally, there are rules of thumb that are useful for different types of studies and surveys. Paying attention to these do's and don'ts may make a difference in the success of a survey.

Traffic Studies

- Preparations should start with a review of the purpose of the study and the type of count to be performed, count period and time intervals required, and information about the site (e.g., volume levels, signal timing).

- Observers must position themselves so their lines of sight are not blocked by trucks or buses and so they can clearly see the traffic they are counting. They must also be located away from traffic flow, however, both for safety and to avoid distracting drivers.

- Using video cameras for counting is expensive, and setting up, recording, and viewing require more time and labor than other methods. Do not count with video unless extreme accuracy is needed or the recording will be reused.

- For further reference, see Chapter 2 of the *ITE Manual*.

Travel Time and Delay

- Observers must be sensitive to changes in traffic or environmental conditions. Speeds may vary during a peak period; therefore, it may be necessary to conduct separate travel time and delay studies for different portions of the peak period.

- For further reference, see Chapter 3 of the *ITE Manual*.

Inventories

- Effective inventories have a clearly stated purpose, provide useful and needed information, are easy to access and pull information from, and are easy to maintain with a minimal effort and cost.

- For further reference, see Chapter 6 of the *ITE Manual*.

Traffic Conflict Studies

- Condition diagrams should be filled out for proper documentation.

- Observers should be concealed from traffic.

- If unusual conditions occur (e.g., construction, accident), a note should be entered on the record sheet to document the time and nature of the condition.
- For further reference, see Chapter 12 of the *ITE*

Manual.

Passenger Surveys

- As a rule of thumb, an interview of 2 minutes is the longest tolerable time for most people. After that, the interview becomes a nuisance to the respondent.

- Under normal queuing conditions, approximately two passengers per minute may be accommodated at flight checkin counters.

- Avoid biases regarding who is surveyed (e.g., men or women).

- It is important to determine how the data from each question will be able to be used in later analysis. If the data are not needed, the question should not be asked.

- A runthrough of the survey may generate awareness of additional variables needed to complete the analysis.

- It is important to differentiate between the categories of airport users, air passengers, airport employees, and airport visitors, because each group has different travel characteristics and transportation needs. The unique characteristics of airport travel patterns for each category of airport user need to be understood.
- To reduce the occurrences of survey bias, it is important to select a large enough sample that includes both air travelers and visitors accompanying the travelers. It is also important that both peak and nonpeak periods during the week and weekend are sampled, because trip purposes differ during these times. The survey should occur over a period of several days, so that a random sample of flights each day can be surveyed, not the same flights each day.

- Because the majority of surveys take place on airport property, it is absolutely imperative that permission to conduct passenger surveys be granted by airport and airline managers.

4.11 Use of New Technologies

More and more, data collection and analysis are being conducted with new technologies that decrease the human effort involved and increase the amount of analysis that can be performed. Planning for future enplanements and future use of the airports is a part of the data analysis. One way to plan for the future is to use airport simulation modeling. This technique supports accurate planning in that it can be used to "integrate all major components between the auto and transit approaches to an airport, through the curb frontage, ticket counters, security, all the way to aircraft in flight."[7] In other words, these models can be used to project future demand on airport access facilities to determine future improvements.

For traffic monitoring and control on airport roadways, there are technologies currently in use in several major domestic and international airports. For example, some airports are able to track bus (remote parking, subway system connection, city) movements by overhead sensors linked by radio to computers that advise bus and airport operators of delays or the need for additional buses. The video detection system (VIDS) at a major international airport uses a dozen programmed sensors to monitor traffic buildup at key terminal frontage locations. With a change of the computer screen, traffic operation staff are able to monitor conditions. Electronic toll and traffic management (ETTM), automatic vehicle identification (AVI), and automatic vehicle location (AVL) technology is being used to monitor HOV, taxi and black car, airport van, and rental car usage.[7] Other examples of technologies that aid in future facility access planning include: permanent counters tied directly to computers that continuously collect data and information from ticket issuing machines (TIMs) at exit lanes to calculate real-time parking lot use, constantly gathering data on current conditions to help plan for future needs.

In addition to data analysis, technology can be used for data collection. For example, a survey of departing air passengers at a small international airport used a palmtop computer. The survey questions were programmed into the computer so that as respondents answered them, their responses could be entered into the computer immediately. Because the level of activity at the airport is so low (140,000 annual enplanements), this technology was preferred over distributing surveys or having the answers written down on a hard copy. The advantage of using the palmtop computer was that the interviewer could easily move around to different areas of the airport. Another advantage was that the data were already entered and could be downloaded directly to the computer and formatted into a spreadsheet. This eliminated the time and effort of having to manually enter the data into a data base. As this technology improves, it may become more useful for larger airports.

Technology is constantly changing, and newer, more comprehensive technologies are constantly being developed. Some new concepts, such as AVI, are currently too expensive to use solely for data collection purposes. Research is needed to determine how the technology can be used most cost effectively to identify needs.

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CHAPTER 5

PATTERNS AND DEMANDS

This chapter provides an overview of how to estimate existing use and future demands for airport access facilities. Key issues to be considered when interpreting and analyzing available ground transportation data, such as the data collected using the survey methods described in Chapter 4, are discussed. Typical techniques, approaches, and rules of thumb that can be used to determine vehicle mode choice, circulation patterns, parking needs, and traffic volumes are also provided.

5.1 Planning Process

The process used to determine patterns and demands for airport access planning is somewhat analogous to the process used for planning transportation facilities serving other types of commercial land uses. Airports, however, have several unique characteristics. Airports generate larger volumes of traffic and serve several different markets, including passengers, employees, and visitors. Each of these markets has unique travel characteristics and may require different facilities and services to accommodate its mobility needs. For example, airline passengers will generally travel much further to go to an airport than people travel to other commercial land uses, while employee trips to the airport may demonstrate trip length characteristics similar to those of other commercial facilities. In addition, airline passengers will often be dropped off by someone else or use special airport access services, such as door-to-door vans.

Figure 5.1-1 illustrates the general process that can be used for determining existing patterns and future demands of groundside airport access trips. The inventory phase involves collecting and analyzing available data (e.g., roadway plans; previous studies; available traffic data; airline passenger, airport cargo, airport employee, and vehicle survey data; and passenger forecasts). The results of these surveys and studies, which are described in Chapter 4, are used to determine existing airport access patterns and demands. These may include the number of trips by different market segments, which modes people use to come and go from the airport, what times they arrive and depart from the airport, what routes they may have used to get to the airport, their circulation patterns on the airport, and other characteristics. In some cases, airport surveys and studies may only provide information about the demands placed on different airport access facilities (e.g., roadway volumes, travel time and delay, curbside use and delays, parking use, etc.), while in other cases more information may be available.

Existing airport patterns and demands can be used to determine how well existing facilities serve access needs, or the LOS

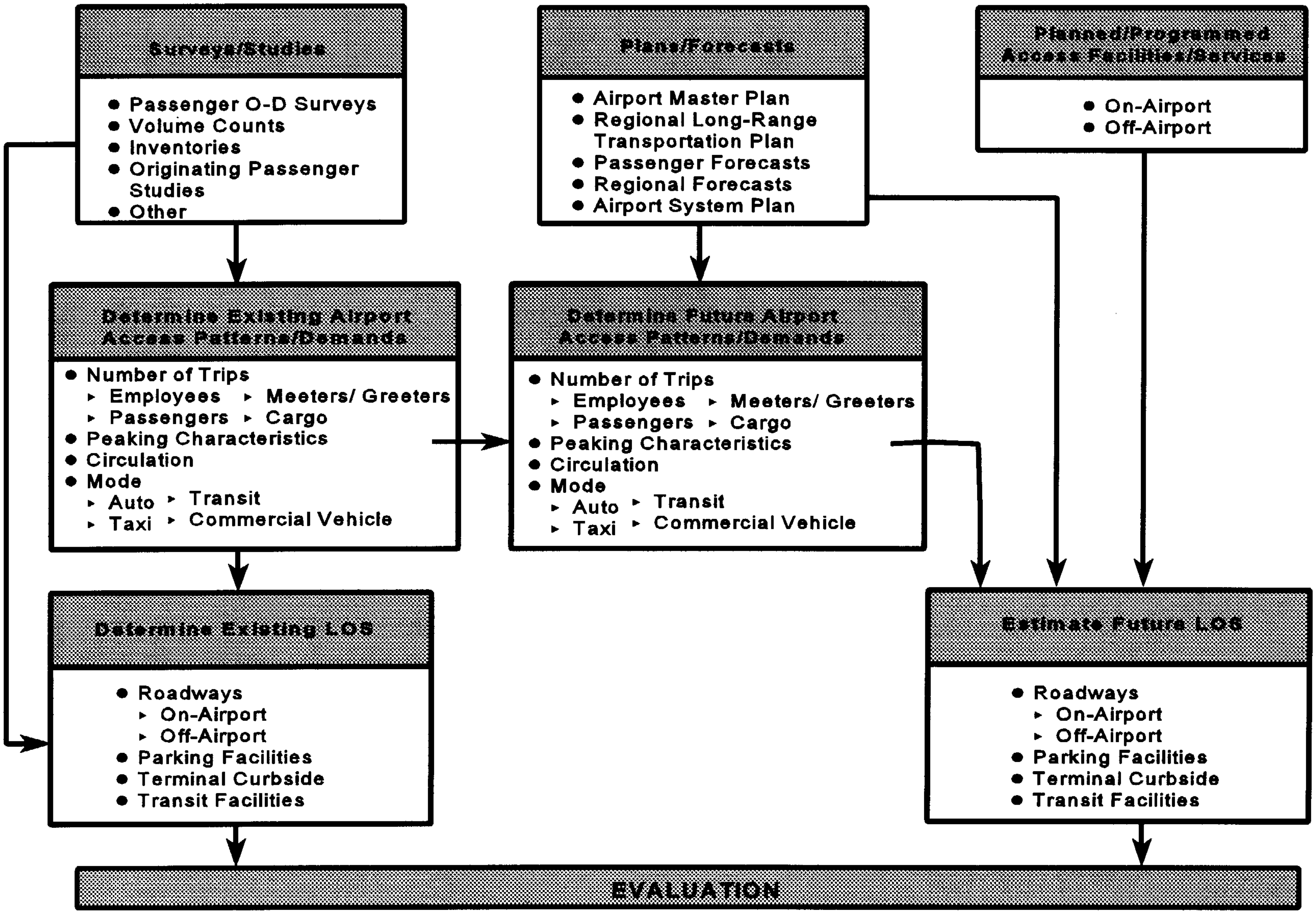

Figure 5.1-1. Process for Determining Airport Access Patterns and Demands

provided. LOS measures how well roadways operate, adequacy of parking, availability and use of terminal curbside facilities, and how well users of commercial vehicles, public transit, and taxis are being served. The roadway planning process typically involves demand v/c analyses, weaving analyses (i.e., merge/diverge), and assessment of safety considerations (e.g., sight distances and placement of crosswalks). Analyses may also be performed to establish if adequate high-occupancy services are being provided. These analyses should establish whether air passengers can get to the airport in a reasonable amount of time from areas that generate a significant number of airline passengers (e.g., major commercial, industrial, and office centers) without using an automobile. While standards exist for determining the adequacy of some facilities and services, others may require qualitative judgment to relate them to airport-specific goals, objectives, and needs.

This LOS analysis will help determine whether appropriate facilities and services are being provided and if those that are provided are operating at an acceptable level. If this assessment identifies inadequacies, new or enhanced facilities and services, described in Chapter 6, can be considered to improve the existing quality and quantity of airport access services and facilities.

Even if the existing LOS is acceptable, airport use will probably grow, and the future adequacy of facilities must be projected. As shown in figure 5.1-1, future airport demands and patterns can be determined using existing patterns, surveys and studies of existing conditions, planned and programmed airport access facilities and services, and future forecasts and plans. This phase can be accomplished in a variety of ways, from fairly simplistic manual methods of analyzing traffic data to more detailed analyses involving computer modeling. Demand estimates are prepared based on an analysis of vehicle mode splits, vehicle occupancies by mode, and volumes for originating and terminating airline passengers, meeters/greeters, and airport employees. Traffic assignment includes careful consideration of vehicle circulation patterns, planned improvements by airport tenants (e.g., future airline operations or addition of major employment centers or maintenance facilities), and airline passenger and employee characteristics (e.g., high levels of business travelers). Most airports factor existing patterns to determine future patterns, but some use forecasting models. If major improvements are planned for landside facilities or the mix between business and nonbusiness passengers will change, then the effect on future patterns and demands must be estimated. Future patterns and demand estimates will determine the need for different airport access facilities (e.g., roadways, terminal curbside facilities, parking facilities, and commercial services).

Future LOS can be estimated using some of the same techniques that are used to determine existing LOS. Future delays and some other measures of LOS cannot be observed; therefore, LOS must either be simulated or estimated, based on forecasted demand and capacity. Alternatives should be considered for improving future conditions, such as those described in Chapter 6. How well these alternatives satisfy airport goals and objectives and estimated future demand should be evaluated.

The level of detail and effort expended for each phase of the planning process depends on a number of factors, such as the nature of the problem, resources available for developing the plan, and time available. Larger airports usually have more access problems and more resources to analyze those problems. If a major airport access planning study is being performed for a large airport, a comprehensive data collection program that provides large quantities of airport-specific information may be part of the process. For access studies at smaller airports and for analysis of minor problems at larger airports, limited data may be available.

Preparation of a detailed terminal plan requires more detailed forecasts of access demands than a typical statewide or regional airport system plan. Compared to the terminal area plan, the regional system plan would require forecasts containing less information on vehicle circulation paths or vehicle mix, but more information on origins and destinations, travel times, and VMT. Before any analysis of airport access is conducted, it is important to clearly define the intended use of the results (i.e., how the analysis helps to achieve the study goals and quantify performance measures). The results of the selected process should be consistent with the level of detail and accuracy needed.

Planning studies may be conducted in two phases. The first phase may result in a relatively inexpensive sketch plan that uses information and rules of thumb provided in this guide. After establishing the general nature of the airport access problem and potential solutions in this first phase, it may be determined that a second, more detailed and expensive phase is warranted. This second phase may include the collection of data, detailed analyses of existing conditions, and detailed future forecasts.

The remainder of this chapter identifies some of the issues to be considered in the planning process, analysis procedures that can be used, typical values, and guidelines for different airport access characteristics and systems. Other information that will aid the planner in determining existing and future patterns and demands for airport access at a specific airport are also discussed.

5.2 Determining Existing Airport Access Patterns/Demands

Existing patterns and demands are best defined by analyzing available data. Data from passenger and employee surveys can be used to establish characteristics of people who come to the airport for different purposes.

Data from passenger surveys can be used to determine the proportion of passengers who are local residents, whether they are traveling for business or pleasure, where their airport access trips originated, the times they arrived at the airport, and what modes they used to get to the airport. Examples of how passenger surveys can be used to determine the demographic and travel characteristics of passengers using the airport are shown in tables 5.2-1 and 5.2-2. Air travelers can be segmented by purpose of their trip (i.e., business or nonbusiness) and residency (i.e., resident of airport service area or visitor). The trip purpose will determine the importance of

Table 5.2-1. Mode of Access by Resident Status

	Los Angeles[1] (LAX)		Baltimore/Washington[2] (BWI)		Washington/Dulles[2] (IAD)		Washington/ National[2] (DCA)		Boston/Logan[3] (LGA)	
Mode Split (Percent)	**Resident**	**Visitor**	**Resident**	**Visitor**	**Resident**	**Visitor**	**Resident**	**Visitor**	**Resident**	**Visitor**
Private Vehicles	71	32	90	39	81	36	54	21	75	33
Rental Car	2	32	1	32	1	33	1	18	1	22
Taxi	4	6	3	11	14	13	31	39	13	27
Other On-Demand	7	4	--	--	--	--	--	--	3	7
Scheduled Bus/Van	7	8	--	--	--	--	--	---	8*	11*
Courtesy Vans	1	8	1	7	1	9	0	9	--	--
Rail	--	--	0	1	--	--	13	7	--	--
Other	8	10	5	10	3	9	1	6	--	--
Total	100	100	100	100	100	100	100	100	100	100

* Includes courtesy vans

Table 5.2-2. Mode of Access to Logan Airport by Residence and Purpose[4]

Mode	Passenger Market Segment (Percent)			
	Resident/ Business	**Resident/ NonBusiness**	**NonResident/ Business**	**NonResident/ NonBusiness**
Dropoff	15	39	10	40
Taxi	13	12	32	14
Long-Term Park	48	16	3	3
Rental Car	2	1	33	18
Door-to-Door Van	8	10	7	4
Scheduled HOV	11	12	5	9
Transit	7	10	10	12
TOTAL	100	100	100	100

different ground access modes at a given airport. Airports that primarily serve tourists often have higher taxi and rental car use than other airports. Furthermore, as shown in table 5.2-1, which presents the mode of access for five airports, the modes used by residents of the airport service area are considerably different than those used by visitors. At these five airports, the majority of residents (54 percent to 90 percent) use the private automobile, while only 20 percent to 40 percent of visitors use private vehicles.

Table 5.2-2 illustrates the proportion of Logan International Airport passengers, desegregated by residence and purpose, using different modes. This table shows that 40 percent of nonbusiness travelers are dropped off regardless of their residency; only nonresident business travelers heavily use taxis and rental cars, and resident business travelers heavily use long-term parking facilities (48 percent). There is not a great difference in the use of HOVs by different market segments (i.e., door-to-door vans, scheduled HOV, and transit), passengers who were residents of the area and making nonbusiness trips were the most likely to use these modes (32 percent). Only 22 percent of visitors who were traveling on business used multi-occupant vehicle modes, as did approximately 25 percent of the other two market segments.

Employee surveys can be used to determine the demographic and travel characteristics of airport employees. These surveys are particularly useful for determining how many trips are made per employee on an average workday, what time employees arrive at work and what time they leave, and what mode they use for theirs trips to work.

Table 5.2-3. Airport Employee Mode Split (Percent)

Airport	Auto Driver	Auto Passenger	Transit	Other
Newark[5]	72	9	17	2
La Guardia[5]	71	7	18	4
Kennedy[5]	80	6	13	1
Logan[6]	88	*	10	2
O'Hare[7]	75	*	21	4

* Auto passenger trips included with auto driver.

Table 5.2-3 shows the modes used by employees to get to work at five large airports in areas with mature transit systems. Between 10 percent and 21 percent of employees traveling to these airports use transit, and less than 10 percent arrive as auto passengers. Even though these airports are in metropolitan areas with the best transit systems in the country, over 70 percent of the airport employees drive to work.

Demographic and travel characteristics of passengers and employees help the planner to define the different market segments that come to the airport. This information can also help establish the options available and how each market segment perceives they are being served. Other data, such as volume counts and travel time and delay analyses, establish the demands placed on airport facilities during peak and off-peak periods. Different facilities may experience different levels of demand during different time periods. These demands can be determined by measuring conditions at specific facilities that represent existing traffic flow characteristics.

5.3 Determining Future Airport Access Patterns and Demands

Forecasts of future airport access patterns and travel demands are required to plan and assess the adequacy of future airport and regional transportation facilities. Forecasts are often used to evaluate facility requirements, test the implications of alternative policy decisions, and establish how well plans will achieve regional and airport goals and objectives.

Forecasts of airport access demands can be estimated using methods ranging from traditional forecasting processes (i.e., trip generation, trip distribution, mode split, and trip assignment) to simpler techniques that use rules of thumb, analogies developed from other airports, or factoring of existing conditions.

As with any other land use, the future access requirements of an airport depend on the level of activity at the airport. Estimates must be prepared of the access requirements for each land use or activity center on the airport. Furthermore, the access needs of an airport are determined by the requirements of each type of activity at the airport. Airport access trips can typically be classified as air passenger trips, employee trips, airport visitor trips (e.g., meeters/greeters or well-wishers), airport tenant trips, and air cargo trips.

Access trips depend on:

- The number of airline passengers
- The number of airport employees
- The number of airport visitors (including well-wishers and greeters)
- The volume of air cargo (including air freight and express and air mail).

Future access needs will also be determined by the travel characteristics of each of these major market segments. Travel characteristics, which will be different for each market segment, include:

- Number of trips generated
- Mode used
- Vehicle occupancy
- Hourly, daily, and seasonal arrival and departure patterns
- On-airport and off-airport circulation patterns.

Table 5.3-1 summarizes the factors that contribute to the travel characteristics for each market segment. Passenger trips and visitor trips are dependent on the number of originating and terminating passengers. The modes the passengers use and vehicle occupancy depend on the trip purpose, party size, and availability of alternative modes. Arrival times depend on flight schedules, and circulation patterns depend on terminal

Table 5.3-1. Factors That Determine Travel Characteristics

		Market Segment			
		Passengers (Originating and Terminating Only)	Visitors (Service, Delivery, and Meeters/Greeters)	Employees (Airline, Airport, and Tenant)	Air Cargo Trips
Travel Characteristics	Number of Trips	Originating and terminating passengers	Number of passengers or aircraft operations, airline and maintenance facilities, etc.	Number of employees or aircraft operations, airline and maintenance facilities, etc.	Air cargo shipments, population, and employment
	Mode Choice	Trip purpose, location of employment and residence, available access modes	Trip purpose and available access modes	Employee income, work hours, available modes, parking cost and availability, employer policies	Not generally applicable
	Vehicle Occupancy	Trip purpose, mode chosen, and passenger group size	Trip purpose, mode chosen, and party size	Employee income, work hours, available modes, parking cost and availability, employer policies	Not generally applicable
	Hourly Arrival and Departure Patterns	Scheduled flight arrival and departure times	Scheduled flight arrival and departure times	Shift starting and ending times	Type of cargo and airport geographic location
	On-Airport Circulation	Enplaning/deplaning, mode choice, terminal design, parking availability	Terminal design, short-term parking availability	Parking availability, roadway design	Parking availability, roadway design

design and availability of parking. Employee trips depend on the number of employees working at the airport, and access mode depends on available options, parking costs, and congestion. Cargo trips depend on the population, employment, and type of industry in a region.

Number of Trips

At most airports, data describing existing and projected airline passengers are more readily available than comparable data for airport visitors, employees, or air cargo operations. Similarly, data indicating airline passenger mode choice, vehicle occupancy, and circulation patterns are more likely to be available than comparable data for airport visitors, employees, or air cargo shippers. As a result, forecasts of the trips generated by airline passengers are often prepared in more detail than analyses of trips by the other groups. However, trips generated by airline passengers may represent less than half of the trips to and from an airport. During peak commuter hours, employee-generated traffic can exceed that generated by airline passengers. Thus, it is desirable but not always feasible, as described in subsequent sections, to prepare forecasts of the trips generated by airport passengers, visitors, employees, and air cargo operations at a comparable level of detail.

Passenger Trips

The need for airport runways and many terminal facilities is generally a function of the total number of enplanements and deplanements at an airport. Enplanements and deplanements

Factors To Be Considered When Determining the Appropriate Forecast Process

- **Data availability**—Do available forecasts of passengers, employees, and air cargo operations provide sufficient detail (e.g., originating passengers rather than total enplanements and peak-hour demands rather than just annual activity)?

- **Horizon years and hours**—Do the forecast years coincide with those used for the regional transportation planning process? Some forecasts of airport activity are presented in terms of number of annual passengers (e.g., 10 million annual passengers, or 10 MAP), and may not correspond to a specific year. Peak-hour airport activity is often expressed in terms of the peak hour of an average day of the peak month, which may not correspond directly to the peak hour used in the available regional forecasts.

- **Available resources and desired schedule**—Are the budget and schedule adequate to prepare a detailed forecast?

- **Time frame**—Is the desired forecast horizon less than 5 years, 10 to 20 years, or more than 20 years?

- **Continued applicability of current data**—Do existing travel patterns form an appropriate basis for determining future travel patterns, or are significant changes expected in regional access patterns or demographic characteristics? Are the forecasts being prepared for an existing or new facility (e.g., the existing airport or a new one)?

- **Study area**—Are the forecasts required of the trips entering and exiting the entire airport property or just those within the terminal building complex or other segment of the airport? Is the primary focus air- passenger- related trips or all airport trips?

- **Policy- versus-design decisions**—Will the forecasts be used to support an evaluation of transportation policies or the design of a specific facility? Typically, facility designs require more detailed forecasts than those used to evaluate policies.

include all passengers who arrive at or leave the airport on a commercial or commuter airplane, including passengers who transfer from one airplane to another. Enplanements at some airports include a large number of passengers transferring from one flight to another, such as Atlanta Hartsfield (62 percent in 1993) and Chicago O'Hare (56 percent in 1993). Other airports have very few transferring passengers, such as New Orleans (9 percent in 1993) and New York LaGuardia (15 percent in 1993). Airport access trips by passengers are not a function of the number of enplanements and deplanements at an airport, but a function of passengers who originated or terminated their flights at the airport.

Few studies have been performed that estimate the number of passenger trips made to an airport as a function of originating passengers. Data compiled for the *California Aviation System Plan*[8] and estimates of originating passengers[9] and enplaning passengers[10] were used to derive a relationship between originating passengers and vehicle trips to California airports. This analysis included 10 California airports ranging in size from Fresno, with under a half million annual enplanements, to Los Angeles International, with over 22 million annual enplanements. This analysis yielded the following equation, which had coefficient of correlation (R^2) approaching 1:

$$\text{Total Vehicle Trips} = (3.526 \times \text{Originating Passengers}) + (.818 \times \text{Connecting Passengers}) - 497$$

In this equation, connecting passengers are defined as enplaning passengers minus originating passengers.

Another study that yields some insights into airport trip generation was performed at Eppley Airfield in Omaha, NE, in 1995.[11] This study related traffic entering and exiting the terminal facility on different days and at different times of the year to enplanements and deplanements on those days. This analysis yielded the following two regression equations, one for vehicle trips entering the airport terminal area and one for vehicle trips exiting the terminal area:

$$\text{Entering Vehicle Trips} = (1.5937 \times \text{Enplaning Passengers}) + 1199$$

$$\text{Exiting Vehicle Trips} = (1.5403 \times \text{Enplaning Passengers}) + 1501$$

These equations yielded very acceptable coefficients of correlation, (R^2) of .815 and .705 respectively, but did not account for passengers who drove to a 3,700-space, off-airport parking facility and did not enter the airport. Over 90 percent of the enplanements at Eppley Airfield are by originating passengers, which makes enplanements in the Nebraska equations comparable to originations in the California equation. Both sets of equations indicate that approximately 3.5 vehicle trips are generated for every originating passenger. This would include vehicle trips by passengers, employees, visitors, cargo vehicles, and others. The California equation indicates that approximately .8 vehicle trips are generated for each connecting passenger.

The Denver Regional Council of Governments (DRCOG) has developed trip generation rates that are used in their regional planning process to estimate person trips and cargo trips to and from air carrier airports in the region. These trip generation rates, which are dependent on regional population and employment, are shown in table 5.3-2.

Table 5.3-2. DRCOG Airport-Related Trip Generation Rates[12]

Trip Type	Trip Rate
Passenger - Home-Based, Nonwork	0.0178/Person
Passenger - Non-Home Based, Nonwork	0.0214/Employee
Other - Home-Based, Nonwork	0.0029/Person
Other - Non-Home-Based, Nonwork	0.0073/Employee
Employee - Home-Based, Work	1.46/Employee
Airport Cargo Vehicle Trips	.0016/Person + .0027/Employee

Employee Trips

Employee trips to an airport are not like those generated by other types of office or industrial employment. An access study at Washington Dulles Airport estimated peak-hour vehicle trips per terminal-related employee from traffic counts. These rates, which are relatively low, are shown in table 5.3-3. That study estimated that only 45 percent of terminal-related employees actually report to work on a given weekday. Another study conducted at Boston Logan Airport estimated that only 60 percent of all employees commute on an average weekday, and between 30 percent and 40 percent of the employees work on Saturdays and Sundays.[13] Furthermore, only 25 percent of weekday employees arrive between 6:00 a.m. and 10:00 a.m., which is the normal a.m. peak period. These unusual commuting characteristics are due to the unusual nature of airport-related employment. Flight crews arrive when they are needed for flights and often will not leave the airport until several days later. Nonflight crew employees may work on shifts, and because airports are often open 24 hours a day, 365 days a year, employees must be at the airport during nontraditional work hours.

Air Cargo Trips

Air cargo operations generate employee and delivery trips (i.e., trucks, vans, and other vehicles that bring cargo to and from the airport). Trips generated by employees working at air cargo facilities can be forecasted if the number of employees by shift is known.

There is no commonly accepted trip generation rate for air cargo delivery trips that applies to all airports, because airlines and airport operators typically record cargo in terms of annual or monthly tons of cargo (with tons of air cargo and freight separated from air mail). There does not appear to be a direct correlation between the number of tons of air cargo handled at an airport and the number of vehicle trips required to transport this cargo to and from the airport.

This lack of correlation results from the fact that the tonnage may vary widely between airports and air carriers, depending

Table 5.3-3. Trip Generation for Terminal-Related Employees[6]

Peak-Hour Vehicle Trips per Employee					
	A.M.		P.M.		
TIME	6:00-7:00	7:00-8:00	1:00-2:00	2:00-3:00	5:00-6:00
Entering	0.065	0.055	0.065	0.050	0.015
Exiting	0.015	0.015	0.035	0.055	0.030
Total	0.080	0.070	0.100	0.105	0.045

on the volume of overnight package delivery services (or small-package express), air freight, air mail, and domestic and international cargo and whether the cargo is transported by a passenger carrier (i.e., belly cargo) or by an all-cargo carrier. Additionally, to forecast the number of air-cargo-generated trips entering and exiting an airport, it is necessary to distinguish between the total number of tons handled and the number that originated or terminated at the airport (i.e., exclude the cargo carried by an airline that is operating a cargo hub at the airport). For example, air cargo hubs, such as Memphis or Louisville, generate fewer access trips per ton of cargo handled than most other airports.

Cargo-handling methods also vary widely and may affect the number of access trips. For example, overnight package services or courier services (such as Federal Express or United Parcel Service) usually assemble large volumes of cargo at off-airport locations and use a few large trucks to transport this cargo to and from their airport terminals. Similar procedures are used by freight forwarders or agents, who operate at off-airport locations near most international gateways. Conversely, a far greater number of access trips per ton of cargo is generated by the small package delivery services operated by air carriers (e.g., Delta Dash).

Because there is no accepted method of determining the volume and characteristics of trips generated by air cargo operations at an airport under study, it is preferable to conduct special-purpose surveys. If the available schedule or resources do not permit such a survey, alternative approaches include using a trip generation rate of: (1) 15 to 20 one-way trips per 1,000 tons of air cargo,[14] (2) 0.7 to 1.0 trips per 1,000 square feet of gross floor area,[14] or (3) the rate identified in table 5.3-2. Such values should be used with caution, however, because of the factors described above.

Mode Choice

Airport travelers and employees may elect to use shared-ride services because of the costs associated with use of the private automobile. Shared-ride access modes may be more attractive alternatives at airports with:

- Limited parking available (e.g., inadequate facilities to accommodate peak demands, reduced on-airport parking because of major construction activity)
- Perceived high parking costs
- Surface roadway or freeway congestion (e.g., possibility of improved travel times with shared-ride modes using HOV lanes).

Air passenger mode choice is determined by a number of other traveler and trip characteristics. These include the purpose of the trip, whether the passenger is enplaning or deplaning, and the socioeconomic characteristics of the passenger.

Mode choice varies depending on trip purpose. For example, business travelers often have greater time constraints and fewer budgetary constraints than some nonbusiness travelers or airport employees. They may select a travel mode that offers a higher level of convenience at a higher cost (e.g., taxi, chauffeured limousine) than can be provided by shared-ride modes of access.

Mode choice may also vary according to the direction of travel of an air passenger trip (i.e., enplaning or deplaning). For example, a recent passenger survey at Los Angeles International Airport indicated that 51 percent of enplaning passengers used private automobiles, compared to 60 percent for deplaning passengers.[1]

Socioeconomic characteristics, including age, income, place of residence (i.e., resident or nonresident), and levels of car ownership, also affect the mode choice process, particularly in considering access mode costs. High-income airport passengers may value the convenience of private automobile use more than the cost savings (e.g., no parking costs) of a shared-ride mode. Residents are typically more aware of alternative access modes (e.g., destinations and relative costs) than are nonresidents and may be more likely to use these alternative modes.

It is important to determine the current percentage of passengers in each of the four airline passenger groups (i.e., resident-business, resident-nonbusiness, nonresident-business, and nonresident-nonbusiness), and forecast whether this percentage is likely to change in the future. Unless a major change in the available access modes or costs is expected, the mode choice distribution pattern of each passenger group is likely to remain constant over time; however, there may be changes from year to year in the proportion of passengers in each of the four groups. Thus, analyses of aggregated airline passenger data may indicate significant increases (or decreases) in mode choice patterns, but may mask that these changes are the result of a shift in the percentage of passengers in each group. For example, surveys at one airport indicated a significant decrease in transit ridership that could not be readily explained, because transit service to the airport had improved. Further analysis of survey data indicated that transit ridership among resident passengers had increased, but total transit mode choice had declined as a result of an increase in the number and percentage of nonresident passengers. Shifts such as this can affect other factors, such as aggregate party size, passenger lead and lag time distributions, and regional approach and departure routing patterns.

At many airports, particularly those with airline hub operations or large maintenance facilities, the number of employees may make up a significant proportion of total roadway traffic (e.g., there are over 30,000 employees at Hartsfield Atlanta and Los Angeles International airports). The special needs and access requirements for airport employees must be addressed, in addition to the needs of the air passengers and visitors. Consideration should also be given to any TDM strategies or local congestion management agency rules requiring employees to use shared-ride modes of transportation.

Although airport planners may develop alternatives designed to encourage the use of access modes other than the private automobile, surveys at some airports that have implemented a new shared-ride mode of access (e.g., fixed rail) indicate minor or no changes in private vehicle mode share for air passengers before and after implementation of the service. Shifts in mode share have typically resulted from passengers switching from one shared-ride mode to another (e.g., from public transit buses to fixed-rail services). The overall proportion of passengers using shared-ride modes, however, has generally remained constant.

The levels of convenience and flexibility afforded by use of the private automobile are major reasons for its continuing role as the primary access mode at most major airports worldwide. Even with the growing environmental and legislative impetus toward use of alternative modes, the use of private automobiles should be given appropriate consideration as part of airport access planning efforts.

Estimating Mode Choice

Very little research has been performed to develop travel demand models that predict the mode of access to airports resulting from proposed improvements to high-occupancy services. A model was developed in 1994 to forecast ridership for a proposed automated guideway transit (AGT) facility to serve New York's LaGuardia and John F. Kennedy airports. This model was based on stated preference analysis.[15] The statistical behavioral choice logit model that was used had the formulation:

$$\text{Probability}_{AGT} = e^{A * \text{Time}_{AGT} + B * \text{Cost}_{AGT}} / \left(e^{A * \text{Time}_{AGT} + B * \text{Cost}_{AGT}} + e^{C + A ** \text{Time}_{\text{CurrentMode}} + B * \text{Cost}_{\text{CurrentMode}}}\right)$$

Where:

$e = 2.7$
C = a constant
A = a coefficient for riding time
B = a coefficient for cost

The development and application of the procedure used to forecast ground access trips for the AGT, including data collection, were very expensive and would probably only be warranted when considering a major rail expansion.

Because travel forecasting models are not readily available, airport planners must have some method for identifying potential use of proposed high-occupancy ground access service improvements. Data on mode of access to airports were assembled from the most recent passenger surveys at over 35 U.S. airports. Figure 5.3-1 shows the minimum, maximum, and median percentage of passengers who gain access to different sized airports via high-occupancy modes (i.e., rail, bus, van, limousine). Even though a clearcut relationship cannot be identified from the available data, several observations about mode of access to airports can be made from figure 5.3-1. The proportion of passengers who use high-occupancy ground access modes to reach an airport generally increases as originations increase. The median value for access by a high-occupancy mode at airports with less than 5 million annual originations is in the range of 11 percent to 15 percent, and the median for airports with over 5 million annual originations is 21 percent. The maximum transit use for airports with fewer than 2.5 million originations is 18 percent and for airports with more than 2.5 million originations, 35.6 percent. Section 6.4 provides detailed information about passenger mode choice at the individual airports. Planners should be able to use these data to identify a comparable airport that has services similar to what is being considered. These data and figure 5.3-1, coupled with a market analysis and professional judgement, should help planners make a preliminary estimate of how much a proposed high-occupancy ground access improvement might be used.

"The stated preference approach is based on interviews with members of the potential market for AGT service, which collect relevant information on how these tripmakers trade off cost, time, reliability, safety, comfort and privacy in making choices among travel modes to the airports. Once the trade-off behavior is identified, it is used to evaluate the actual trade-off situations passengers and employees are expected to experience in 2003, the ridership projection year, and thus to develop the ridership projection. The stated preference approach used here is an AGT study based on an extensive survey research effort completed at JFK, of passengers and employees using the airports, and also the travel alternatives of those individuals."[45]

Peaking Characteristics

To analyze the demand for ground transportation facilities, such as roadways, parking lots, and curbsides, it is first necessary to determine the "design period" that best represents the demand condition for which a facility should be planned. Demand for a facility is usually represented as traffic volume using a roadway, the expected number of parked vehicles in lots or at the curbside during a given design period,
or the number of people using HOV service. The design period varies by the type of facility being planned. For example, roadway and curbside facilities are usually planned to accommodate traffic volumes expected to occur during a peak 1-hour period, called the design-hour volume; however, some

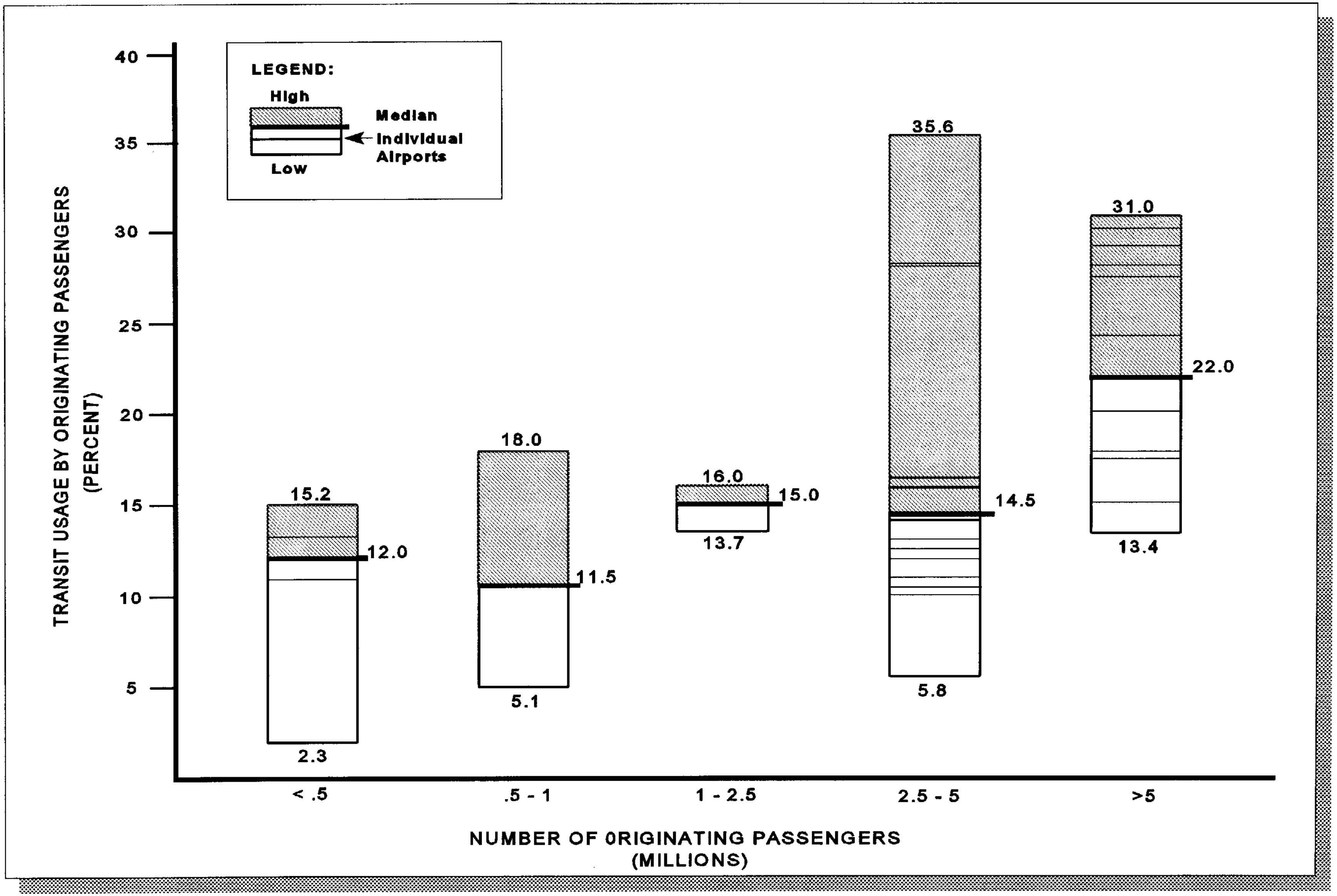

Figure 5.3-1. Use of High-Occupancy Modes at U.S. Airports

facilities may be designed to accommodate traffic volumes occurring over 15-minute periods. Parking lots intended for short-term use (e.g., less than a 3-hour duration) are also sized to accommodate peak hourly volumes, but long-term and daily parking facilities are frequently sized to accommodate demand expected to occur on a given day of the week.

The level of demand accommodated by ground transportation facilities varies by season, day of the week, and hour of the day. Reasons for this variation, which are outlined in the following paragraphs, should be considered when analyzing data to determine facility demands.

Seasonal Peaking

Facility demands vary by month during the course of a year. For example, during peak holiday travel months, such as November and December, airport parking facility use and roadway congestion usually increase compared with off-peak periods. Airports usually experience relatively high facility demands during July and August, when vacation travel activity is high. At airports located in States with warm weather resort destinations, such as Florida and Arizona, the peak month may occur during April (spring break from school).

Daily Peaking

Facility demands vary by day of the week. For example, peak roadway traffic volumes may occur early or late in the week as business travelers begin or end their trips. Consequently, the demand for long-term parking facilities may be the greatest during the middle of the week (e.g., Wednesday) when most business travelers are "on the road." At airports with a high number of nonbusiness or leisure travelers, peak demands may occur on weekend days. Figure 5.3-2 illustrates these kinds of variations by showing daily variations in traffic entering the terminal areas, for 3 weeks in 1996 at Eppley Airfield in Omaha, NE. Daily traffic levels are fairly consistent from Sunday through Friday during the June and September periods, with Friday showing the highest volumes. However, during Thanksgiving week, the volumes are higher than during the other weeks, and volumes are much higher on Tuesday, Wednesday, and Sunday.

Hourly Peaking

Facility demands vary by time of day and by type of traffic accommodated by the facility. At large airports, separate roadways and curbsides are often provided to accommodate different passenger activities (e.g., enplaning vs. deplaning passengers, international vs. domestic passengers). Each of these facilities must be designed to accommodate the activity occurring at that facility during the design period. For example, roadways and curbsides serving the enplaning level or area of a terminal building should be designed to accommodate traffic activity related to the peak period of originating airline passenger activity. However, the curbside peak hour would actually occur before, or "lead," the peak hour for originating passengers. Similarly, the deplaning level curbside peak hour would occur after, or "lag," the peak hour for passengers terminating their trips at the airport.

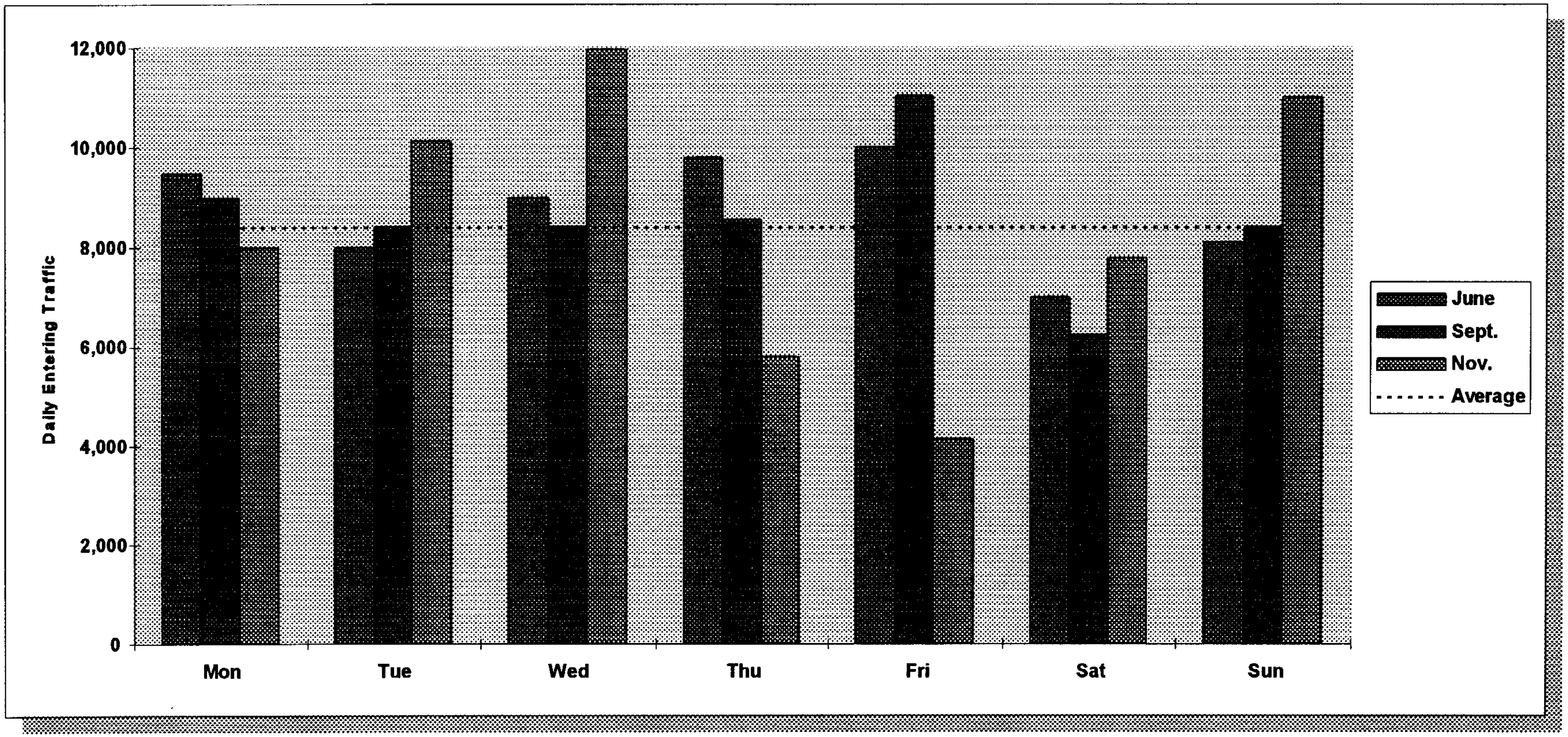

Figure 5.3-2. Daily Variations of Traffic Entering Eppley Airfield[11]

Figure 5.3-3 displays the peaking characteristics of a major international airport serving an East Coast metropolitan area. Note that the peak period for traffic entering the airport is 4:00 p.m. to 6:00 p.m. and that the peak-hour traffic is nearly double that which occurs during other times of the day. Contrast that with the temporal distribution for another airport serving the same metropolitan area displayed in figure 5.3-4. This airport primarily accommodates domestic flights serving areas within 1,000 miles. Traffic entering this airport is consistent between 6:00 a.m. and 6:00 p.m. with only a slight peak between 3:00 p.m. and 6:00 p.m. The difference between these temporal distributions is a good example of why the planner should carefully examine the characteristics of the airport under study. The characteristics of access trips to each airport depend on the unique characteristics of that airport.

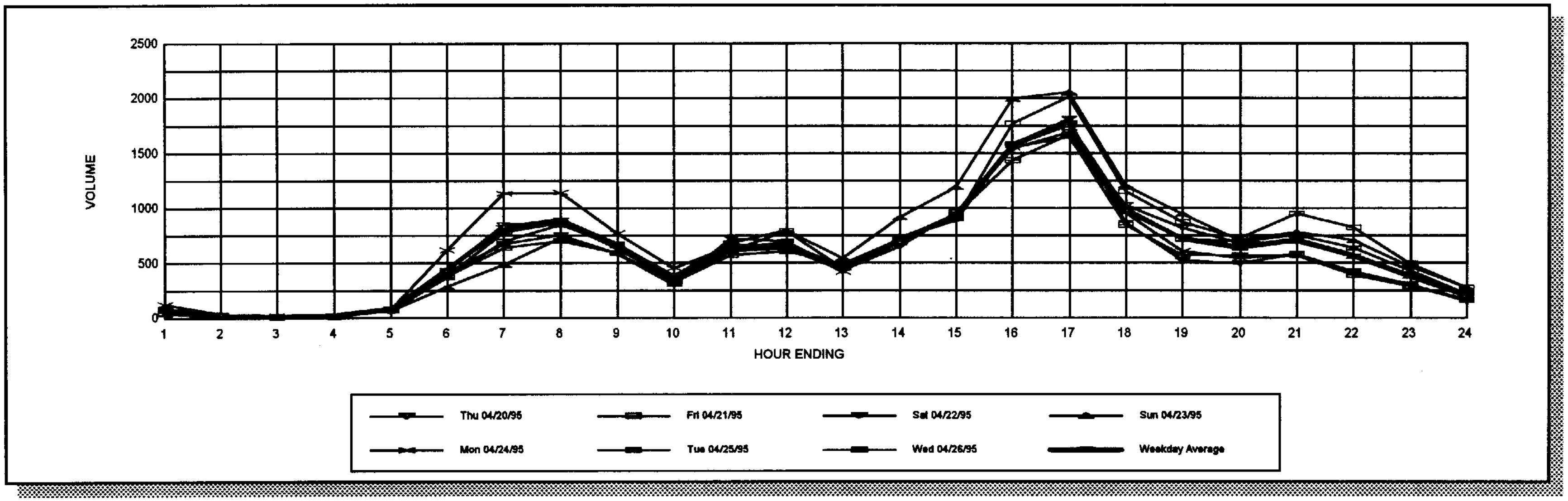

Figure 5.3-3. Temporal Distribution of Total Traffic Entering a Major International Airport[16]

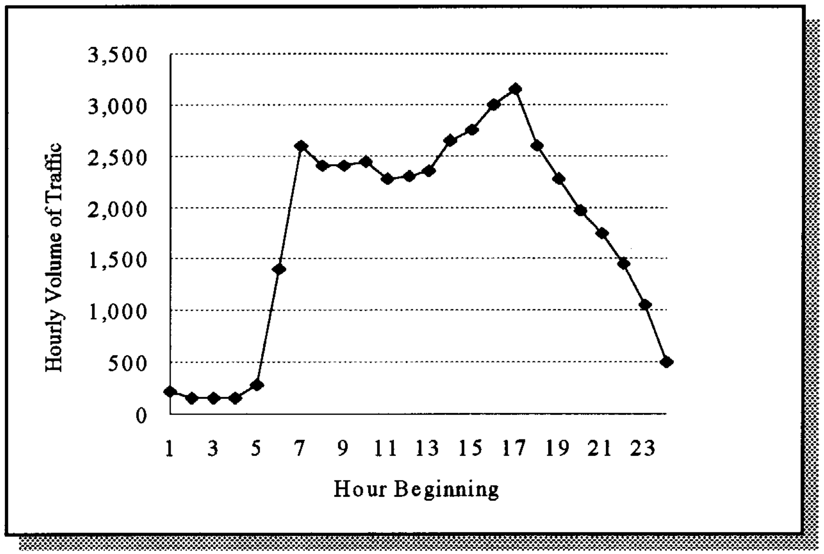

Figure 5.3-4. Temporal Distribution of Traffic Entering a Major Domestic Airport[17]

Along airport service roadways and nonpublic roadways, peak-hour traffic volumes may be generated by airport employees, cargo-related vehicles, service vehicles, and other nonairline passenger traffic. Peak demands for the combination of these vehicles must be accommodated. Employee arrival times at the same international airport for which total traffic is shown in figure 5.3-3 are shown in figure 5.3-5. Employee trips peak between 1:00 p.m. and 2:00 p.m., just before the peak for total airport traffic.

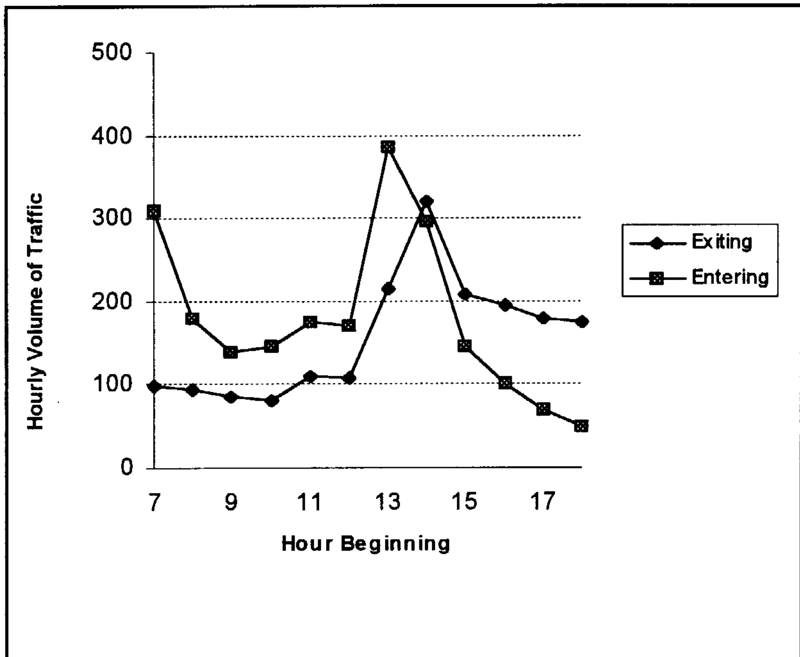

Figure 5.3-5. Employee Arrival Times at an International Airport[16]

Trip Distribution

Trip patterns for airport access trips can be separated into on-airport circulation patterns and off-airport trip distribution. On-airport circulation depends on the purpose of the trip and the airport design. Off-airport trip distribution also depends on trip purpose, but it is more dependent on regional growth patterns and off-airport facilities that serve the airport. Table 5.3-4 describes the factors that influence trip distribution patterns for the on-airport and off-airport portions of an airport access trip.

<u>On-Airport Circulation</u>

On-airport circulation patterns vary, typically depending on the physical configuration of the roadways and facilities serving the airport, including the locations of:

- Entrances and exits to parking and rental car areas
- Recirculation roads
- Terminals (single or multiple terminals)
- Passenger pickup and dropoff areas
- Commercial vehicle staging facilities
- Curbside spaces (i.e., space allocation).

Table 5.3-4. Factors Influencing Distribution Patterns of Airport Access Trips

Type of Access Trip	Passenger	Employee	Visitor	Air Cargo
On-Airport	Proportion of passengers using curbside and parking facilities.	Location of employee parking and transit facilities.	Curbside and parking availability.	Location of air cargo facilities and cargo vehicle entrances to airport.
Off-Airport	Place of residence, place of employment, tourist attractions, and available access routes and services.	Place of residence and available access routes and services.	Regional demographics and available access routes and services.	Location of air cargo handling agents and clients, warehouses, and industrial facilities.

For example, at airports without a conveniently located recirculation roadway, visitors accompanying airport travelers may elect to park and assist the traveler in carrying baggage from the garage, instead of dropping off the passenger, recirculating, parking, and meeting the passenger at the departure gate.

The circulation patterns of most private vehicles (or rental cars) can be categorized into those presented in table 5.3-5. Circulation patterns are different for air passenger trips originating at an airport and terminating at the airport. Table 5.3-5 also provides representative values for each circulation pattern related to air passenger trips originating and terminating at an airport. Given an estimate of private vehicles gaining access to an airport, a planner may use these values to establish an initial estimate of volumes that can be anticipated on different on-airport roadway segments.

Planners should also account for commercial vehicles that circulate between the terminal curbside areas and staging facilities that are often located in remote lots and parking garages.

Off-Airport Circulation Patterns

Forecasts of regional travel patterns to and from the airport are determined by where passengers came from, the available or committed future regional access network (i.e., highways, transit, and shared-ride services), and the perceived travel times and costs of the network.

For passenger trips, particularly business trips, travel time reliability is a key factor in passenger selection of access routes and access modes. Off-airport travel patterns for commercial and private vehicles are often based on the locations of regional population and employment, tourist attractions, hotels,

Table 5.3-5. Typical On-Airport Private Vehicle Circulation Patterns

Circulation Pattern	Description	Percentage of Originating Trips	Percentage of Terminating Trips
Enter-Park	The driver proceeds directly to a parking facility, avoiding the terminal curbside areas.	15-45	0
Enter-Curb-Park	The driver proceeds to the terminal curbside for passenger dropoff or pickup and then continues to the parking facility.	15-25	0
Enter-Curb-Exit	The driver proceeds to the terminal curbside for passenger dropoff or pickup and then exits via the roadway system.	40-60	35-45
Park-Curb-Exit	The driver leaves the parking facility and proceeds to the terminal curbside for passenger pickup before exiting via the airport roadway system.	0	15-25
Park-Exit	The driver leaves the parking facility and exits via the airport roadway system.	0	35-50

off-airport parking, and rental car facilities. The availability of off-airport parking and ground transportation terminals will affect off-airport travel patterns in the immediate vicinity of the airport. Off-airport travel patterns are important for planning local and regional facilities and services that serve airport access trips. HOV services, such as public transit, airport bus services, or door-to-door van services, should serve major concentrations of employees or passengers. Adequate highways that provide access to the airport need to be planned, particularly in the vicinity of the airport. On-airport circulation for airports with more than one entrance may be determined by the off-airport origin of trips.

The distribution of existing off-airport air passenger traffic is best established from the results of passenger surveys. Figure 5.3-6 displays the off-airport distribution of air passenger access trips that were gathered from a passenger O-D survey in the Washington, DC area. The off-airport distribution of air passenger access and egress trips will change as the region served by the airport changes.

If areas of the region experience a growth in office space or commercial land uses, more air passenger trips will either begin or end from that area. Likewise, if increases are projected for higher income residences in some areas of the region, airport passenger access and egress trips to those areas will also grow. The best way to project future off-airport trip destinations is to factor existing patterns using the forecasts of household and employment that are prepared by the MPO.

The off-airport origins and destinations of airport employees are usually considerably different than those of air passengers. Airport employees generally live closer to the airport than passengers. The origin of employee trips to an airport can be determined from an employee survey, if available. An estimate of the regional distribution of employee trips can also be made from the regional travel forecasting process used for transportation planning by the local MPO. Future distributions can also be derived from these regional forecasts.

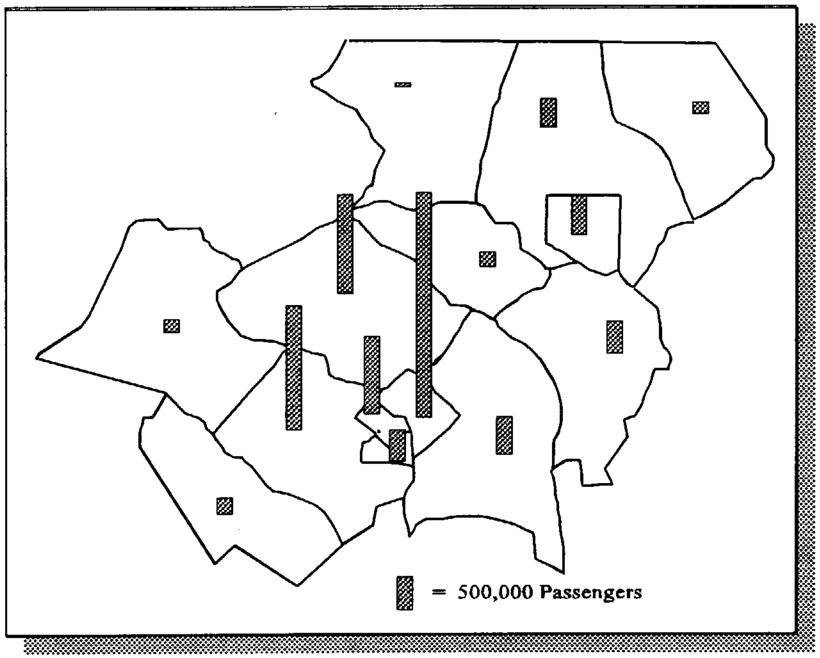

Figure 5.3-6. Regional Distribution of Traffic Using a Washington, DC Airport[18]

Air passenger and airport employee trips generally represent only a small portion of travel demands on the regional transportation system. However, because airport access is important to the economic vitality of the region, trips to and from the airport should be included in the regional and local transportation planning processes. If airport access planning is performed for an airport, the regional models should be modified to reflect the results of those plans. This could be accomplished by adding the off-airport trips by mode resulting from an access study to a regional trip table or factoring regional trip tables to reflect access study results. Including airport access trips in other transportation planning processes will ensure that local and regional planning efforts will accommodate airport access trips when planning future transportation facilities.

Curbside Demand Forecasts

Curbside demand is a function of the volume of traffic entering the curbside roadway in front of a terminal building, the proportion stopping to dropoff or pickup passengers at the curbside, the length of time these vehicles remain at the curbside (dwell time), and the effective space the vehicles occupy (i.e., the vehicle length plus the maneuvering space needed to enter and exit). The primary factors influencing curbside operations and dwell times are:

- Access management policy (e.g., tolerance of double-parking, enforcement) of an individual airport

- Specific enforcement policies (e.g., level of enforcement, police presence)

- Degree of traffic congestion (the amount of double-parking at the curbsides)

- Vehicle mix and dwell times

- Airside activity (e.g., peaking characteristics of arrivals and departures, use of high-capacity aircraft).

The factors influencing the volume of traffic on curbside roadways stopping to dropoff or pickup passengers are the availability, convenience, and cost of public parking; typical passenger group size; and number of bags per passenger. Curbside demand is usually greatest near doorways and skycap positions (curbside checkin counters). As airports reduce the use of tickets for verifying air travel reservations, the demand for curbside checkin will increase. This will likely increase the need for curb-front dropoff areas.

The length of available curbside is determined by eliminating from actual curb lengths the space adjacent to columns or other obstructions and areas where vehicles are prohibited from stopping. Effective curb length can be estimated at 1.3 times the "available curb-front," which assumes that the available curb-front plus 30 percent of the adjacent maneuvering lane can be used for passenger pickup and dropoff.[19] Several different approaches are available for approximating curbside demand. A first-order approximation of curbside demand can be estimated at 0.5 feet per peak hour enplaning (originating) passenger and 0.8 feet per peak hour deplaning (terminating) passenger.[20] A more precise method for estimating curbside demand is to use the anticipated traffic volume by mode and the average vehicle processing time (time that vehicle will remain at the curb). If the peak-hour demand is known, the dwell times and vehicle slot lengths shown in table 5.3-6 can be used to estimate the needed length of curbside. A sample calculation of required curb length is shown in table 5.3-7.

Sufficient capacity should be provided to allow vehicles to circulate through the curbside area. The inside, or curb lane, cannot accommodate any through-traffic, the outside lane can accommodate 300 vehicles, and all additional lanes, 600 vehicles.[21]

Table 5.3-6. Expected Curb Frontage Dwell Time and Vehicle Slot Length[22]

Vehicle	Curb Dwell Time (Minutes)		Vehicle Slot Length (feet)
	Enplane	Deplane	
Private Auto	1.0 to 3.0	2.0 to 4.0	25.0
Rental Car	1.0 to 3.0	2.0 to 4.0	25.0
Taxi	1.0 to 2.0	1.0 to 3.0	20.0
Limousine	2.0 to 4.0	2.0 to 5.0	35.0
Bus	2.0 to 5.0	5.0 to 10.0	50.0

Table 5.3-7. Sample Calculation of Curb Length Needs

Vehicle Classification	Peak-Hour Volume	Equivalent Peak Hour*	Dwell Time (Minutes)	Required Spaces	Vehicle Length (Feet)	Required Length (Feet)
Automobile	148	178	3.5	11	25	275
Taxi	37	44	3.0	3	25	75
Courtesy Vehicle	56	67	4.0	5	30	150
Shared-Ride Van	29	35	4.0	3	30	90
Scheduled Vehicle	7	8	5.0	1	40	40
Luxury Limousine	6	7	3.0	1	25	25
Total	283	339	-	24	-	655

* Assumed to be four times the peak 15-minutes.

5.4 Parking Patterns

Parking at airports is a critical part of the airport access problem, especially when existing facilities are expanded. Many airports suffer from lack of adequate parking and frequently experience periods when demand equals or exceeds supply. Convenient public parking with sufficient capacity is necessary to avoid congestion on airport roadways and at terminal curbsides.

Several facets of airport parking require investigation and analysis to achieve an effective, comprehensive parking program. These aspects include:

- Number of parking spaces required
- Distribution of spaces by duration of stay and user type
- Type of parking facility (e.g., structured, surface, or remote)
- Location of parking facilities
- Methods/costs of operation
- Parking rates
- Technologies available to achieve more efficient management and revenue control.

Parking Characteristics

Before undertaking a parking study, an understanding of the basic characteristics (e.g., length of stay) of the typical airport parking patron is required. Research has revealed that 70 percent to 85 percent of the vehicles park for less than 3 hours. On the other hand, long-term (over 24-hour) parking dominates the parking space demand. Typically, about 75 percent of the users can be served by 10 percent to 30 percent of the spaces, but the remaining 25 percent of the users may require up to 90 percent of the spaces. Duration of stay of parking users at a specific airport may be determined from an analysis of the parking tickets collected at the various facility exits.

As a general guideline, based on these percentages and subject to the characteristics of the particular airport, about 20 percent to 30 percent of the public parking supply should be provided for short-term parking (i.e., an average stay of 3 hours or less), and the remaining 70 percent to 80 percent should be provided for long-term or remote parking.[22 23]

Time required for passengers to locate a parking space and walk or ride to or from the terminal building, and the conditions under which passengers must make this trip, are important elements of the LOS provided to airport patrons who park at an airport. Generally, airports try to maintain a maximum walking distance of 800 feet between the parking facilities and the terminal buildings; airports usually provide a shuttle service for parking beyond that distance. Because it is often difficult to find the few remaining empty spaces when parking facilities approach capacity, airport parking facilities should operate at practical capacity (i.e., with 85 percent to 95 percent of the total number of spaces filled) during peak periods.

Parking Demand

The most critical and challenging task when providing an efficient parking program is determining precisely how many spaces are needed at a particular airport. Providing insufficient spaces can have negative consequences, not the least of which is the agonizing delays to airline passengers who must search for empty spaces. On the other hand, providing many more than the optimal number of spaces causes unnecessary expenditures by the airport authority.

Various formulas or ratios have been developed for determining the number of parking spaces that should be provided at an airport. Indices of spaces per enplaned passengers (e.g., annual or average monthly) are frequently used; however, because transfer passengers do not create parking demand, standards based on locally originating passengers are more meaningful. The parking required to meet the needs of airport passengers depends on the number of originating passengers, the modes they used to get to the airport, and the length of their trips. In the absence of airport-specific data, a first-order estimate of parking needs can be derived from parking provided by other airports. An analysis was performed of parking facility data collected by ACI-NA in 1991, and these data were used to develop a relationship between parking supply at hub airports and the annual number originating passengers.[24]

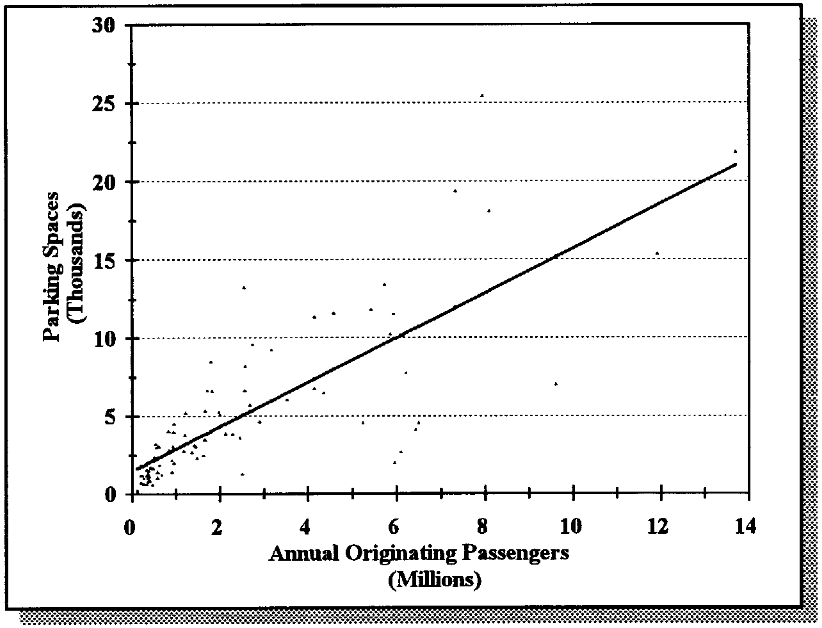

Figure 5.4-1. Relationship Between Originating Passengers and Parking Spaces

This relationship is displayed in figure 5.4-1 and can be approximated using the equation:

Parking Supply =
1,476 + .001427 x Annual Originating Passengers

The regression coefficient (R^2) for this equation is 0.75. Other rules of thumb that have been used for estimating airport parking demand include:[25]

- 900 to 1,200 parking spaces per million annual enplaned passengers
- 1.5 spaces per peak-hour passenger
- 1 space per 500 to 700 annual enplaned passengers (small or nonhub airports).

Figure 5.4-2 displays the number of parking spaces supplied by airports with different levels of passenger activity. Based on this figure, it is possible to conclude that medium and smaller size airports require more parking spaces per originations than large airports.

Public parking demand at airports (not including specific user groups) varies widely and is not always consistent with originating passenger volumes. Other factors that affect public parking demand at airports are:

- Number of nonpassenger, visitor trips
- Duration of stay
- Modes of ground travel (e.g., automobile, transit)
- Passenger trip purpose (e.g., business, vacation)
- Parking rates at various facilities (e.g., short-term, intermediate, long-term, off-airport)
- Percentage of dropoffs.

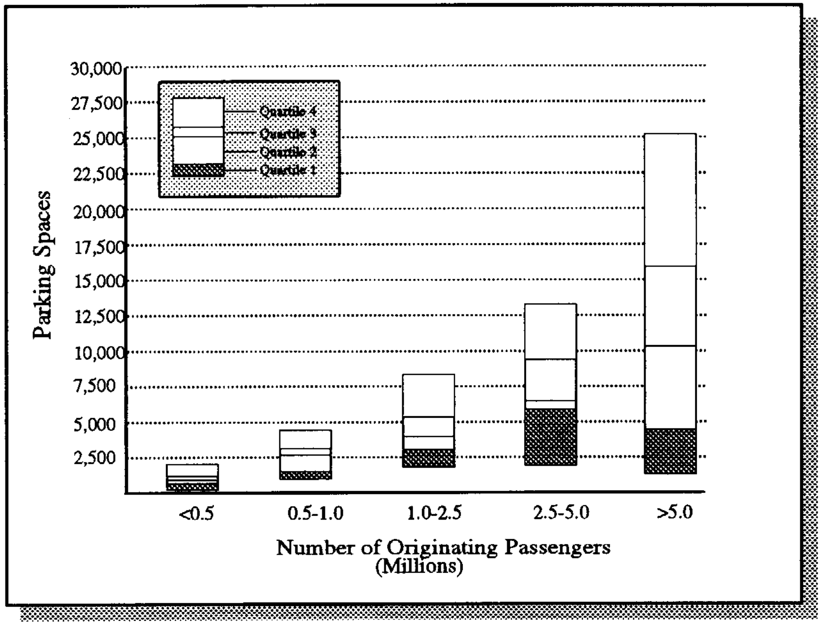

Figure 5.4-2. Parking Supply by Originating Passengers

Typical Parking Study

After the distinctive and individual characteristics of a particular airport have been documented, parking studies can be undertaken to determine the nature of the parking demand and/or adequacy of the existing parking in terms of capacity for each type of parker (e.g., short-term, intermediate, long-term, remote), as well as for particular user groups (e.g., employee, tenant). Understandably, airport studies put more emphasis on the characteristics of the type of parker (i.e., length of stay), rather than the user group. Typically, the results of an airport parking study would define the ratio of demand-to-capacity for each type of parker.

Inventory and usage data are among the elements required for a parking study. Inventory consists of a space count of each facility and curbside area, including restrictions, rates, and type of operation (e.g., meters, valet service). Usage consists of data on time of arrival and length of stay for each parker by facility and day of the week. This information can be obtained for an existing airport from an analysis of the parking tickets collected at various parking facility exits. From these data, such measures of efficiency as accumulation, duration of stay, and turnover rates can be computed. The results of these airport parking studies will identify demand and space allocation problems. Alternative solutions to parking needs, which will be discussed in section 6.6, can then be developed. A thorough knowledge of the specific requirements of employees, concessionaires, and tenants is needed to provide adequate parking facilities for those groups. Table 5.4-1 lists the various phases and tasks, as well as an abbreviated work

description for the demand analysis, involved in a typical airport parking study.

Financial Analysis — Structured Parking

Because of land values and shortages, as well as the need to have parking close to the terminal area, most airport administrations have to make a decision regarding the feasibility of providing structured parking. Table 5.4-2 illustrates that $1,500 per car space would be the annual revenues needed or the breakeven point required to amortize the construction costs and pay the operating expenses for a hypothetical 1,000-car airport parking structure. Based

Table 5.4-1. Typical Parking Study

Phase I — Parking Demand Analysis
• Conduct organizational meetings — review existing data
• Analyze existing parking conditions/characteristics - inventory (spaces, type, restrictions, rates) and usage data (turnover, length of stay, distribution, accumulation, trip purpose) - type of parker (short-term, intermediate, long-term, remote) - user group (visitors, employees, tenants, related services) - LOS (time required to park, conditions, walking distance)
• Determine existing and future parking demands - number of originating passengers using parking facilities - number of nonpassengers, visitors (e.g., dropoffs/pickups, airport-related business) - distribution (percent of spaces long term, percent of spaces short term) - peak accumulation and occupancy for each type of parker - ratio of demand-to-capacity or adequacy of existing parking for each type of parker - short-term (i.e., less than 3-hour duration) facility size to accommodate peak "design hour" volumes (peak hour of an average day in the peak month) - long-term facility size to accommodate peak "design day" of the week
• Develop alternative solutions — parking improvement options
Phase II — Site, Design, and Cost Appraisals
• Evaluate/select site • Determine traffic impact • Develop schematic drawings, prepare total project cost estimates • Assign administration and operation of the parking facility/program
Phase III — Financial Implications of Parking Program or Facility
• Determine method of financing for the program/parking structure • Develop parking rate schedules • Prepare hourly, daily, annual usage/income projections • Develop anticipated operating expenses • Prepare summary of revenues, expenses, and debt service coverage

Table 5.4-2. Financial Analysis for 1,000-Space Airport

Total Project Cost (Revenue Bond Issue)	
Land Cost	0
Construction cost (1,000 cars @ $25/sq. ft.)	$8,125,000
Fees and contingencies related to financing and construction)	$2,440,000
Bond issue amount	$10,565,000
Annual Breakeven Point Expenses	
Debt service amount (assuming level principal and interest payments are 10 percent for 20 years)	$1,100,000
Operating and maintenance expenses ($400 per space)	$400,000
Total	$1,500,000

on average parking revenues of $1.15 per enplaned passenger, slightly more than 1,300,000 annual enplaned passengers would be needed to financially justify this new multilevel parking structure.[25]

Example Assessment of Airport Parking Demand

Describe Existing Use

An airport with annual traffic of approximately 5 million enplaned passengers has a total of 2,200 parking spaces available and finds that lots close to the terminal building, for both short-term and long-term parking, are 75 percent to 90 percent full between Tuesday afternoon and Thursday afternoon almost every week. Remote lots, which contain 600 spaces and are used primarily for long-term parking, are seldom more than 50 percent full.

Describe Operating Factors

Approximately 70 percent of existing enplanements are originations. There have been no recent surveys of passenger access modes, but management estimates that perhaps 55 percent of the business-traveler market served by a new airline coming to the airport will choose, if possible, to drive and park at the airport and that the average duration of trips will be approximately 2 days.

The new airline is expected to offer 6 flights a day, serve primarily originating passengers, and use aircraft with seating capacities of 100 to 130 passengers.

Estimate Service Levels and Service Volumes

Because close-in long-term lots are nearly full midweek, there may indeed be a need for more parking and the long-term daily maximum of $6 could be increased. However, there are at least 300 spaces potentially available in the remote lots. In an effort to maintain the overall service level, the airport management would like to add capacity to accommodate the demand, above current levels, and to maintain this condition as demand grows.

Current midweek space needs are estimated as follows:

Current spaces needed:

= (Filled Spaces) x (115 Percent Allowance for Adequate Service Level)
= (2,200-300) x (115 Percent)
= Approximately 2,200 Spaces

That is, current parking capacity is apparently just *equal* to the demand, given the desired service level.

The parking supply of 2,200 spaces represents an average rate of 0.63 spaces per 1,000 annual originating passengers at the airport. If all new passengers (150,000 to 195,000 new enplaning passengers are expected annually) are assumed to be originating or terminating their trips, maintaining the level of parking supply at this rate would require 94 to 123 new parking spaces.

Employee Parking

Although only about half of the daily traffic at many airports is generated by airline passengers and accompanying visitors, there has been a noticeable lack of emphasis on and planning for nonpassenger trips. It has been suggested that 250 to 400 employee parking spaces should be provided per million annual enplanements. At many airports, 90 percent of airport employees use the private automobile for travel to work. Employee, tenant, and other nonpassenger parking should be provided near working areas or destinations when these areas are not near the terminal buildings. Otherwise, remote parking facilities with an employee shuttle service to the work areas should be provided. Studies have revealed that remote or off-airport parking involving a shuttle service is more acceptable to employees than it is to airline passengers.

On the other hand, many airports have not shown a consistent relationship between employees and passengers because of variations among airports for such activities as aircraft maintenance or air cargo (e.g., a major maintenance base, airline flight crew base, airline hub). As in other service industries, extra large employee parking areas may be needed to accommodate shift change overlaps.

Many airports, most notably in California, are instituting programs to improve air quality through a reduction in vehicular trips (and resulting emissions) generated by employees. Of course, this also serves to reduce congestion on the airport roadways and makes more parking spaces available for other users. These TDM programs are described in section 6.6.

5.5 Other Factors

Other factors that may affect airport ground access activity and should be considered when analyzing and interpreting data include the following:

- Nonstandard occurrences — Traffic incidents near the airport (e.g., vehicle accidents or roadway construction) could interfere with traffic flow on airport roadways and could bring bias to data collection. During the Gulf War in 1991, the implementation of Level IV security measures at many airports created significant changes in traffic patterns, vehicle mode choice, and traffic volumes. Vehicles were rerouted away from terminal building curbsides or parking structures with high levels of pedestrian activity. Other incidents that could affect data collection might include special events, such as major conventions or sporting events.

- Introduction of new airport services — For example, the introduction of low-fare air carrier service could induce additional passenger demands, thereby affecting traffic volumes, mode choice, parking lot use, and other facility data, as compared with historical information. Also, the implementation of new ground transportation services could create a significant shift in mode choice. At San Francisco International Airport, for example, door-to-door van service was introduced in 1985, and by 1993, the door-to-door service market share had expanded to account for about 12 percent of total airport trips.
- Capacity-constrained facilities — When access roadway or parking facilities provide insufficient capacity to accommodate the demand for the facility, airport users may choose to use other travel modes to avoid traffic congestion or parking at the airport (e.g., taxis, rail, or off-airport parking facilities). Consequently, data gathered from constrained facilities would not represent the unconstrained conditions for which a facility should usually be planned.

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Figures

Tables

CHAPTER 6

ALTERNATIVES FOR IMPROVING AIRPORT ACCESS

Once the current airport access situation is understood and future conditions have been forecasted and assessed, it is necessary to consider access improvements that will provide the desired existing and future LOS to passengers coming to the airport. Alternative strategies for improving airport access conditions are available. No single type of improvement is appropriate for every airport access situation and airport environment. Alternative approaches could include capital-intensive improvements, such as a new highway or rail transit link, or operational improvements, such as improved express bus service. In many cases, it is not a single solution, but a combination, that comes closest to meeting the needs of a given airport. The appropriate solution is often defined by community and airport goals, environmental considerations, and fiscal constraints. Alternatives should be carefully evaluated for their effectiveness at a given airport and to determine how well they satisfy the performance goals and evaluation criteria that have been established.

This chapter of the guide reviews alternative types of airport access improvements and provides specific examples and characteristics where available. Included are improvements related to:

- Access roads
- Parking
- Terminal curbside facilities
- Rubber-tired and rail transit options
- Intermodal facilities
- Demand management techniques, such as TDM strategies and application of ITS technology.

6.1 Access Roads

The discussion of access roads to airports is divided into the following topic areas: off-airport, near-airport, and on-airport. Traffic and access road considerations vary, depending on proximity to the airport and the relative size and activity level of the airport. Improved vehicular access to airports can be achieved through physical and operational changes implemented on roads in regions that are far removed from the airport, as well as on roads that are in proximity to it, including those that provide direct airport access. In addition, improved traffic flow can be achieved from improvements to circulation roads and other roads that are on airport property.

Considerations Related to Access Roads Off Airport

Major airports are special trip generators that attract a variety of trip types, including home-based work trips, home-based nonwork trips, nonhome-based trips, truck trips, and others. From a regional perspective, a highway network should be established that provides safe and efficient access to airports and serves the variety of trips. All routes that serve the major airports and key links in the region's highway network should be included in the regional perspective. Adequate navigational information should be provided to motorists on highway guide signs in advance of and at key route choice decision points. For example, proper signs should be provided on all appropriate interstate highways, other freeways and expressways, and selected principal arterial highways to direct motorists to major airports. Transportation planners can use travel forecasting models to identify the shortest routes from all origin zones to the zone containing an airport. Plots of the paths produced by these regional transportation planning models can be used to identify routes where navigational information to airports should be provided.

Guidelines are provided in the *Manual on Uniform Traffic Control Devices (MUTCD)* on a general informational symbol sign that may be used to identify a route leading to an airport.[1] This sign, shown in figure 6.1-1, features white letters on a green background. For guide signs that display the name of the airport and directional information, some states have developed

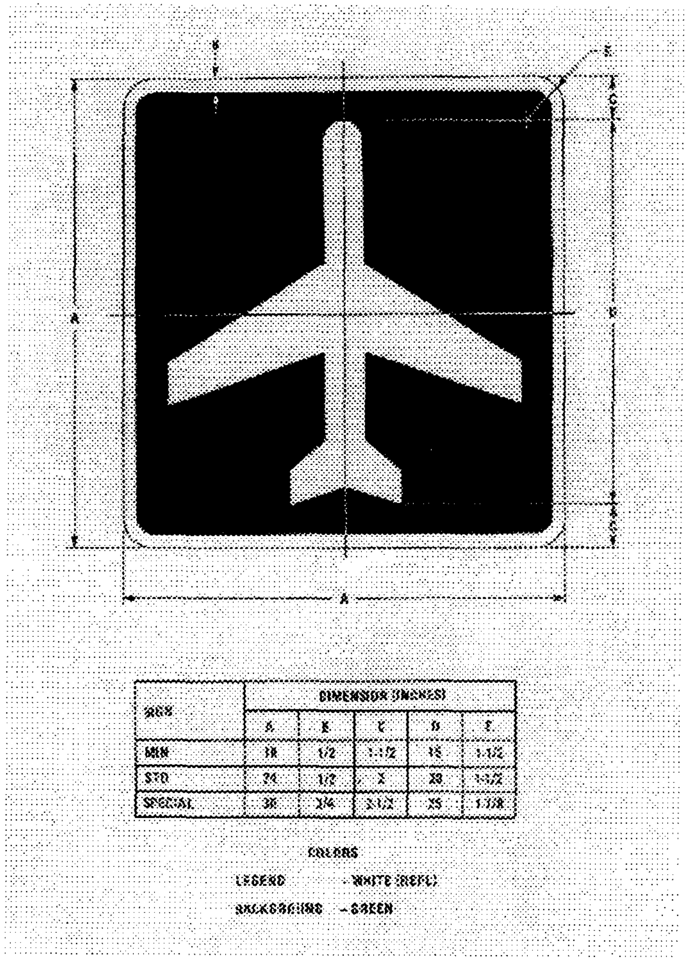

Figure 6.1-1. MUTCD General Informational Symbol Sign

and employed application criteria. As cited in a 1980 National Cooperative Highway Research Program synthesis of highway practice,both Florida and South Carolina have criteria for providing supplemental signs on freeways for airports, as summarized in table 6.1-1.[2]

Table 6.1-1. Guideline Criteria for Airport Signs[2]

Type of Area	Florida		South Carolina	
	Number of Regularly Scheduled Movements (One-Way) per Day	Distance From Airport (Miles)	Number of Regularly Scheduled Flights (One-Way Departures) Per Day	Distance from Airport (Miles)
Major Metropolitan Areas	≥ 40	≤ 10	≥ 20	≤ 8
Urban Areas	≥ 30	≤ 10	≥ 10	≤ 8
Rural Areas	≥ 20	≤ 10	≥ 10	≤ 8

As shown in table 6.1-1, Florida recommends that signs be placed on facilities within 10 miles of a major metropolitan airport with 40 or more flights per day.

The ITE has developed guidelines for airport roadway signs entitled, *Airport Roadway Guide Signs, A Proposed Recommended Practice*, which offers the following:

> Generally, there are one or two major feeder roads to an airport. All of the major roads which intersect these feeders within a radius of 10-25 miles from the airport should carry the airport message as an integral part of their highway destination signs, including overhead signs.[3]

In addition, special logos for specific airports have been developed and integrated into guide signs on freeways. Figure 6.1-2 depicts a sign that shows a specialized airport logo, which is located on Interstate 95 northbound, approximately 10 miles from Baltimore-Washington International (BWI) airport.

ISTEA called for the development of an NHS that would, among other things, provide improved access to airports and ports, which are the Nation's link to international commerce. According to the FHWA document entitled, *National Highway System, The Backbone of America's Intermodal Transportation Network*, most major airports have adequate access, but they are expected to face increasing problems with peak period congestion.[4] The NHS will provide resources to improve existing access routes to tomorrow's airports. This will enable plans for airport expansion and the required ground access to be much more closely integrated. The proposed NHS, which

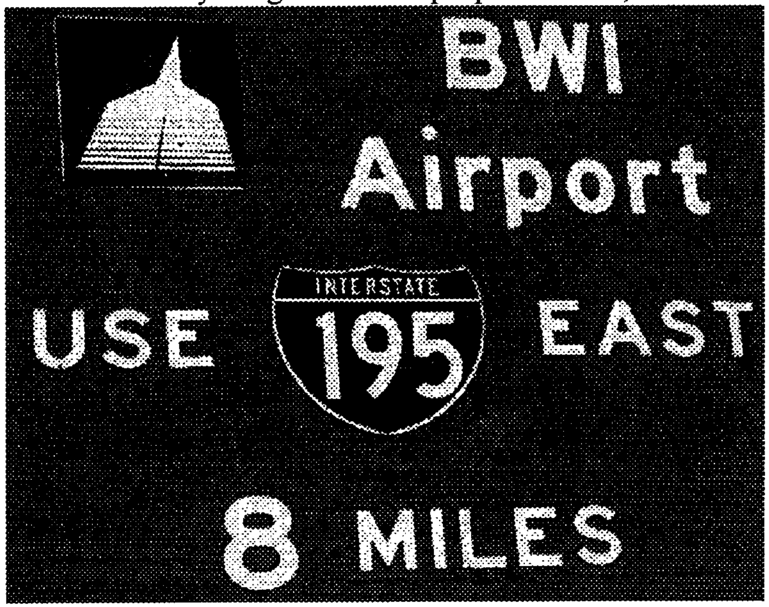

Figure 6.1-2. Specialized Airport Logo

was approved by Congress in November 1995, included roads that served a total of 143 airports.

Needs related to emergency vehicle access to and from airports must not to be overlooked when examining the regional context of airports. To ensure adequate emergency medical service response times, the highway segments that constitute the shortest routes between hospitals or major medical centers and the airport, along with redundant routes, should be identified and considered for improvements. In addition, the shortest routes from existing and planned local fire and rescue stations that support the airport should be identified and reviewed.

Potential highway capacity bottlenecks for these vehicles should be identified and mitigated through geometric or operational changes.

<u>Geometric Design Alternatives</u>

Geometric design alternatives are related to construction and physical changes in a roadway's alignment, cross-section, intersections, or interchanges. Cross-section changes that increase highway capacity include the following:

- Widening highways to provide additional travel lanes
- Constructing medians and median dividers
- Extending left-turn storage lanes
- Constructing additional right- and/or left-turn lanes at intersections
- Widening paved shoulders
- Implementing minor geometric improvements at access points and intersections

Alignment changes include:

- Straightening sharp horizontal curves
- Lengthening short crest and sag vertical curves

- Realigning skewed intersections to achieve 90-degree angles

- Reducing grade differentials at at-grade intersections.

Construction changes implemented at key interchanges and intersections in highway corridors that serve the airport can also improve airport accessability. Detailed information on geometric improvements is included in *A Policy on Geometric Design of Highways and Streets.*[5]

Traffic Operation Alternatives

Alternative traffic operation upgrades can also be implemented to improve access to airports. In addition to improving highway signs, which was discussed earlier in this section, traffic operation alternatives include:

- Improvements in traffic signal operation on arterial roads that lead to airports, including:
  - Changes in signal phasing and timing at individual intersections
  - Implementation of signal synchronization or "optimized" coordinated signal timings
  - Implementation of traffic-responsive signal systems
  - Introduction of proactive preventive traffic signal maintenance programs

- Improvements in traffic surveillance systems, incident detection and response systems, and traffic control systems for freeways

- Implementation of traffic management centers that coordinate incident management

- Implementation of improved traffic information dissemination systems.

Considerations Related to Access Roads Near Airports

Citing a 1966 NCHRP report, the ITE's *Traffic and Transportation Planning Handbook* states:

> Although airports may be among the largest single-site travel generators in major metropolitan areas, they account for only a fraction (usually less than 2 percent) of the total travel within those areas, so their measurable traffic impacts are usually limited to those parts of the highway network within a radius of a few miles. The localized impacts on roads providing direct airport access can be quite severe, especially where total airport traffic discharges into an already busy urban expressway as at Chicago's O'Hare or New York's La Guardia and Kennedy Airports.[6]

Consequently, far greater attention should be devoted to the examination and improvement of the capacity of roads in the immediate vicinity of airports, especially those that provide direct access to the airports. It should be noted that temporal vehicular traffic distributions vary among airports, depending on the number of flight arrivals and departures, the degree of support and cargo services provided at the airport, the degree of nonairport-related employment within the airport property, and seasonal factors. Temporal distribution of airport-related traffic was discussed in Chapter 5.

Geometric Design Alternatives

All the improvements discussed for off-airport roads apply equally to roads in the immediate vicinity of the airport. Improvements to at-grade intersections, grade-separated interchanges, and ramps that serve existing primary airport access roads can result in travel time savings to motorists bound for the airport. In some cases, burgeoning traffic demands through a critical at-grade intersection may warrant consideration of a grade-separated interchange. Additional discussion on warrants for upgrading to grade-separated interchanges can be found in *A Policy on Geometric Design of Highways and Streets*.[5]

Airport access can be greatly improved by the construction of new roadways, including dedicated roadways that lead directly to the airport and spurs from freeways that are constructed in accordance with interstate design standards. Access highways to large airports should have full control of access with no crossings at grade. Figure 6.1-3 illustrates the proportion of

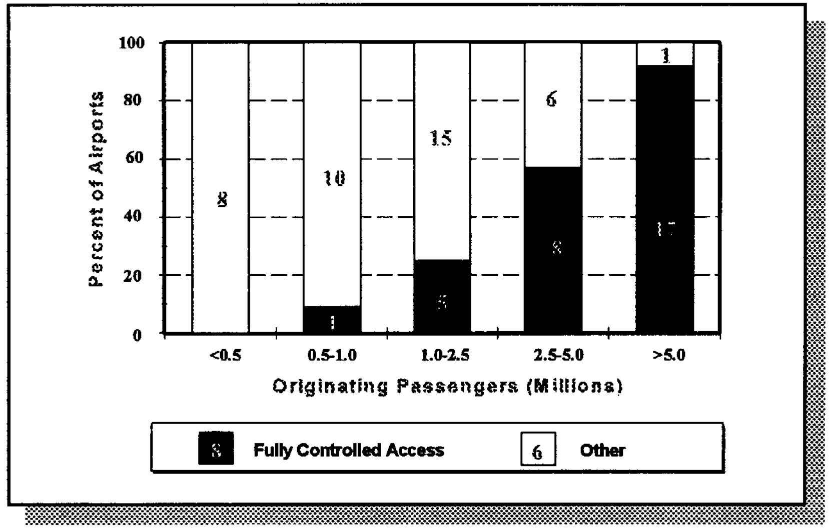

Figure 6.1-3. Primary Airport Roadway Access Facilities

different size airports that are directly served by controlled access facilities. As can be seen, most airports that have more than 2.5 million annual originating passengers are served by fully controlled access facilities, while only 20 percent of the airports with 1 to 2.5 million annual originations are. Only one of the 19 airports with fewer than a million originations is served by controlled access.

It may be desirable to establish exclusive express lanes, such as the Dulles Airport Access Road, that lead directly to the airport within existing highway corridors that serve the airport. The highway capacity of primary airport access roads should be sufficient to accommodate the anticipated and projected traffic demands for the specific airport.

Some airports provide more than one major access roadway in order to provide sufficient capacity; however, this is usually limited to larger airports, as shown in figure 6.1-4.

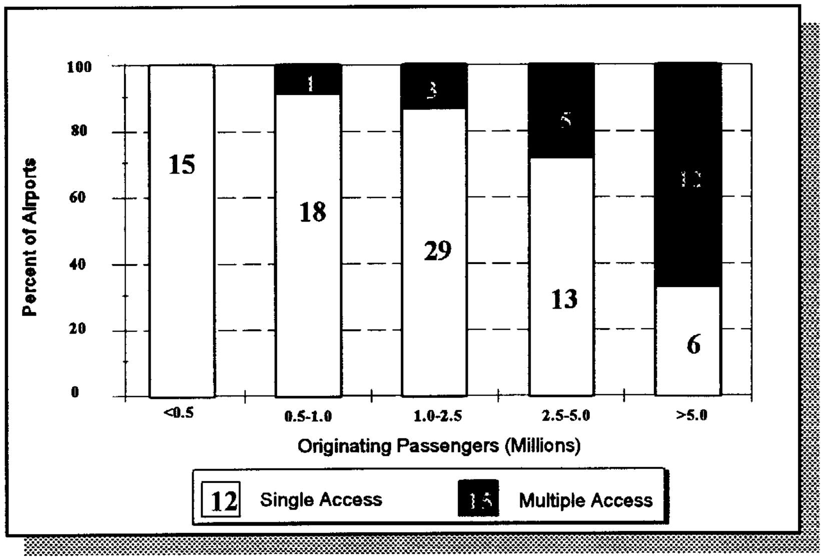

Figure 6.1-4. Airports With Multiple Access Facilities

Traffic Operation Alternatives

Improvement alternatives identified for off-airport facilities also apply to roads in the immediate vicinity of the airport. Additional traffic operational improvements on roads in proximity to the airport have been implemented to facilitate access to airports. Most notable is the use of Highway Advisory Radio (HAR). As far back as 1977, there were two HAR systems in operation at Houston Intercontinental Airport. The primary information that was broadcast was related to parking conditions.[7] The Los Angeles International Airport has also had an HAR system in operation to assist motorists in locating various facilities since before 1980.[2] Changeable message signs have also been used on roads outside airport boundaries to present information to drivers about construction and temporary traffic and parking conditions at airports. Additional information on the use of changeable message signs can be found in other references.[8 9]

Considerations Related to On-Airport Roads (Excluding Terminal Curbside Areas)

The topic of traffic operations at airport terminal curbsides will be addressed in section 6.3. This section deals with other roads and traffic operation considerations within the airport property.

Vehicular traffic entering an airport is composed of different airport users, including the following:

- Passengers:
  - Local residents on business travel
  - Local residents not on business travel
  - Nonlocal residents on business travel
  - Nonlocal residents not on business travel

- Spectators, visitors, and meeters/greeters

- Employees and Others:

- Airport employees
- Airline crews
- Nonairport employees working at locations within the airport property
- Customers of airport and other services
- Nonairport employees delivering goods and services.

It is important to recognize that motorists can be bound for a variety of destinations within the airport property. Many airports include on-airport hotels, retail stores within and outside the terminal, commercial offices, and cargo/shipping service centers and terminals. There are also a wide variety of vehicle types that come to an airport, including personal vehicles (e.g., automobiles, pickup trucks, vans, motorcycles), commercial vehicles (e.g., taxis, limousines, shared-ride vehicles, buses, jitneys, hotel courtesy buses, and rental car vehicles based off airport), and cargo vehicles (single-unit trucks, tractor-trailers). In addition, there are shuttle buses and other vehicles that operate entirely within the airport property.

Airport Circulation

Components of airport landside circulation include the following:

- Airport roads

- Terminal curb areas:
  - Curb frontage
  - Sidewalk platforms
  - Curbside baggage check in
  - Terminal entranceways
  - Pedestrian crossings and walkways

- Public parking facilities:
  - Short-term areas
  - Long-term areas
  - Parking area/structure lot entrances and exits
  - Parking area circulation roads/aisles

- Public transportation and rental car areas.

The layout and types of terminal concepts at an airport determine the integration of the components that form the airport circulation system. Several of the more typical airport circulation configurations are shown in figure 6.1-5 and described in table 6.1-2.

Airport roads have been classified as follows:

- Primary airport access roads

- Terminal area access roads

- Recirculation roads

- Terminal frontage roads

- Service roads:
  - General use
  - Restricted use.

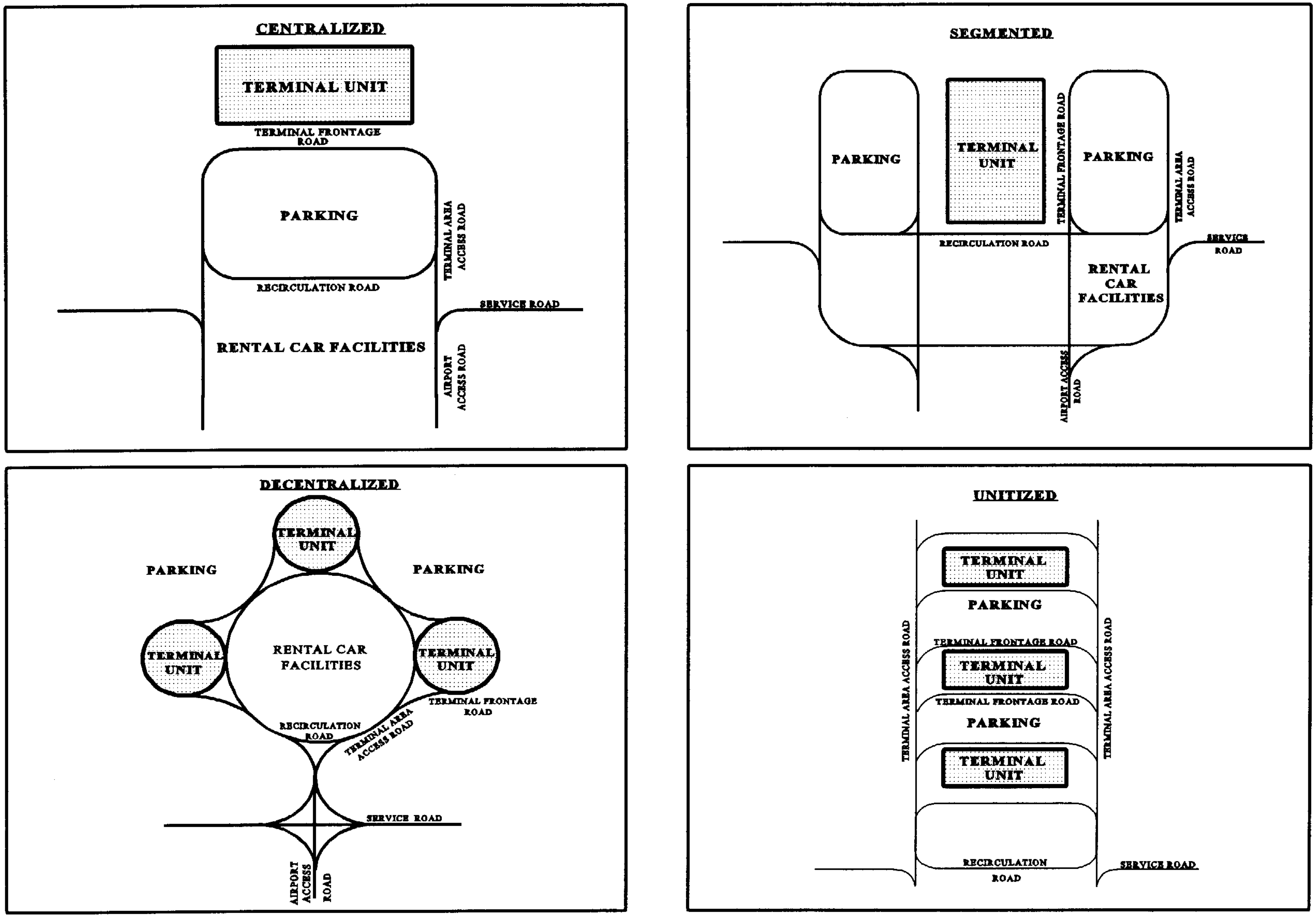

Figure 6.1-5. Typical Airport Circulation Systems[10]

Table 6.1-2. Description of Typical Airport Circulation Systems[10 11]

Type of Layout	Description	Means of Expansion	Examples
Centralized	Terminal complex consists of a single building or a contiguous series of buildings. All passenger-related vehicles normally pass through same series of roadways. Public parking and car rental facilities are centrally located.	Terminal unit expansion along existing terminal area access road without loss of original ground access system concept.	- Chicago O'Hare - San Francisco Int'l - Los Angeles Int'l - Atlanta Hartsfield - Washington National - Ft. Lauderdale - Hollywood Int'l
Segmented	Terminal building divided into originating and departing passengers or grouping of airlines on either side. Originating passengers use one set of terminal frontage roads and terminating passengers, the other.	Terminal unit extension with retention of the same ground access system.	- Orlando Int'l - Jacksonville - Greater Cincinnati
Decentralized	Airport access and terminal access roads funnel traffic to and from separate terminal facilities. Parking and car rental facilities are grouped on a terminal unit basis.	Addition of terminal units around the terminal access road with separate terminal frontage roads.	- Kennedy Int'l - Kansas City Int'l
Unitized	Access from centrally located roadway. In some cases, may consist of a series of terminal buildings located in a linear fashion.	Addition of terminal units between terminal area access roads.	- Dallas-Ft. Worth Int'l - Houston Intercont'l

Primary airport access roads include those roads that provide primary access to the airport from the regional transportation network. Terminal area access roads serve airport passengers, visitors, and employees and connect primary access roads with terminal buildings, air cargo, parking, and service facilities. Recirculation roads provide road sections to link the ingress and egress lanes of the access road. In some cases, there are both terminal area recirculation roads and terminal frontage recirculation roads. Terminal frontage roads distribute vehicles directly to terminal buildings. If more than one terminal building exists, there may be more than one terminal frontage road. General-use service roads are used for the delivery of goods, services, air cargo, and flight kitchen supplies, among other uses. General-use service roads provide connections between the airport and terminal access roads and the nonpassenger land uses at the airport, such as air cargo facilities, concessionaire service facilities, airport maintenance areas, and employee parking areas. Restricted-use service roads are limited to airport maintenance, fire and rescue, fuel, baggage, freight, and aircraft service vehicles. Sections of restricted-use service roads that provide access to aircraft operating and parking areas require control points for security reasons. The typical operating characteristics of airport roadways are described in table 6.1-3.

Table 6.1-3. Characteristics of Airport Roadways[10 11]

Characteristics	Primary Airport Access Roads	Terminal Area Access Roads	Recirculation Roads	Terminal Frontage Roads	Service Roads
Desirable hourly lane capacity (vehicles/hour/lane)	Arterials: 700-800 Freeways: 1,200-1,600	900-1,000	600	Inside lane: 0 Outside lane: 300 Additional through-lanes: 600	600-1,200
Average speeds (mph)	Arterials: 20-25 Freeways: 40-50	20-25	N/A	10-20	15-20
Desirable demand-volume to capacity ratio	Arterials: 0.80 Freeways: 0.60	0.60-0.70	N/A	N/A	N/A
Desirable minimum number of lanes and lane width	2 lanes, 12 ft	2 lanes, 12 ft	1 lane, 20 ft 2 or more lanes, 12 ft	4 lanes: Adjacent to curb (8 ft + 12 ft) Through-lanes (12 ft + 12 ft)	2-lane, 2-way, 12 ft

Principles for Design and Operation of Airport Roads

Terminal area access roads should be sufficiently long to permit the smooth channeling of traffic into appropriate lanes for safe access to terminal curbsides, parking lots, and other public facilities.

Ample separation should be provided at locations where drivers must make route choice decisions to avoid driver confusion. Not more than two route choices should be required of a driver at any location.

A minimum of four lanes adjacent to the terminal curb is recommended to avoid congestion caused by double-parking. Four lanes are also recommended when the terminal arrivals and departures are on the same level. Service-related traffic and passenger-related traffic should be separated. At large airports with centralized airport layouts, originating passenger traffic and departing passenger traffic should also be separated. This can be accomplished through the vertical separation of terminal frontage roads.

At airports where several terminal buildings exist, it is desirable to separate traffic for the various passenger terminal buildings, thereby reducing the traffic volumes on individual terminal frontage roads. If only one terminal frontage road exists, then all traffic must pass each terminal building, resulting in greater traffic flows and possible congestion on the terminal frontage road.

Traffic circulation in front of the terminal should usually be one-way and counter-clockwise for convenience of right-side loading and unloading of vehicles. Adequate transition areas for lane additions and lane reductions should be provided where possible. Taper lengths should conform to the *MUTCD*.[1] Recirculation of vehicles to the passenger terminal should be permitted. When several terminal buildings exist, it may be advisable to provide more than one terminal road.

Traffic streams should be separated at an early stage with appropriate signing to avoid congestion and assure lower traffic volumes on each of the terminal frontage roads. At very large airports, it is desirable to provide service road entrances and interchanges before or shortly after the airport entrance to relieve congestion on airport terminal access roads. (At low-activity airports, the service and primary airport access roads may be concurrent).

The needs of the pedestrian should be considered in the design of pedestrian facilities within the airport. Generally, the pedestrian wishes to take the shortest route to a given destination that still provides an acceptable level of risk. Exposing pedestrians to numerous conflict points should be avoided. When designing for pedestrians, an airport planner should:

- Separate pedestrians and vehicular traffic
- Establish pedestrian/bicycle networks
- Consider special provisions for bicycles

- Maximize safety at pedestrian crossings by providing adequate sight distance, signs, and pavement markings. In general, pedestrian crossings should be at 90 degrees to vehicular traffic. Grade separation of pedestrians and vehicular traffic should be considered where the number of pedestrian-vehicle conflicts is expected to be very high

- Minimize the number of at-grade crossing points.

Traffic signal control should be limited to only those locations where warranted *and justified* in accordance with guidelines specified in the *MUTCD.*[1]

The design of the airport roadway system must also include adequate provisions for the following:

- Satellite parking areas
  - Access from the airport entrances to the satellite parking lots
  - Access from the satellite parking lots to the terminal(s)
  - Access from the terminal(s) to the satellite parking lots
  - Access from the satellite parking lots to the airport exits

- Access to, and circulation around, on-airport intermodal stations, including transit stations

- Rental car areas
  - Access from the airport entrances to the rental car return areas
  - Access from the rental car return areas to the terminal(s)
  - Access from the terminal(s) to the rental car pickup areas
  - Access from the rental car pickup areas to the airport exits
  - Access from the rental car pickup areas to the terminal(s)
  - Access from the terminal(s) to the rental car return areas

- Safety considerations for parking lot and parking structure access points (parking is covered in detail in section 6.2)

- Taxi and public transportation staging and parking areas
  - Storage (staging) and dispatching of taxis and other commercial vehicles
  - Access from the airport entrances to temporary storage areas
  - Access from taxi temporary storage areas to terminal curbside.

Given that a significant percentage of originating and departing passengers use taxis and other commercial vehicles, the quality of traffic flow on airport roads is greatly affected by how taxis are managed and how well roadways serve their needs.

<u>Roadway Design To Accommodate Airport Taxis</u>

To increase curbside operating efficiency, short-term parking areas for buses, taxis, and limousines are often located away from the terminal curb-front. These vehicles can be called to the curb in a demand-response mode, considerably reducing curb-front dwell time. Provisions can be made for exclusive lanes or dedicated auxiliary curbs for these commercial vehicles. Parking space for 160 vehicles per acre is recommended.[11] Table 6.1-4 presents the results of a 1986 survey of approximately 175 airport managers. As noted, most large and medium airports have holding areas for taxis. Overall, 68 percent of the airports that responded to the sample had holding areas.

Geometric Design Alternatives

Changes to roadway geometry are often implemented to increase highway capacity, improve traffic flow, and enhance highway safety. There are a large number of geometric improvement alternatives that can be considered for roadways within an individual airport. Applicability of these alternatives is greatly affected by the physical conditions that already exist at the airport. Physical constraints may preclude certain construction alternatives. Institutional barriers and limitations will also influence the range of alternatives. Potential geometric improvements are:

Roadway Network

- Construct separate service roads for trucks and service vehicles
- Construct additional through-lanes on the major airport and terminal area access roads
- Construct or widen paved shoulders
- Upgrade airport and terminal area access roads to freeways with full control of access
- Improve roadway connections between the terminal(s) and the rental car areas
- Construct separated roadways to allow commercial vehicles to travel directly to the arrival curbside
- Construct or widen service roads that provide access to and from satellite parking areas

Table 6.1-4. Airport Manager Survey Results Related to Taxi Holding Areas[12]

Airports	Holding Areas for Taxis	Gated Holding Areas for Taxis
Large Airports (28)	100%	23%
Medium Airports (34)	94%	35%
Small Airports (110)	52%	13%
All Airports (172)	68%	22%

Interchanges

- Lengthen merge areas

- Improve diverge areas at key route choice decision points for the terminal(s) and parking areas

- Lengthen weaving areas and/or construct additional auxiliary lanes

- Improve sight distance and other ramp geometrics

At-Grade Intersections

- Provide separate right-turn and left-turn lanes

- Provide channelization and turning roadways at intersections, where appropriate

- Install traffic signal control when warranted and justified

- Implement other geometric design improvements, (e.g., increase intersection radii)

- Construct grade-separated interchange to replace a service drive and airport access road intersection

Driveways and Other Access Points

- Increase width of driveways to allow for passing stalled vehicles

- Construct deceleration and, if appropriate, acceleration lanes for entrances to the major roads

- Consolidate driveways and access points that are in proximity

- Apply access management principles and design treatments[13]

- Separate basic conflict points

- Limit or restrict (by physical means) access onto the airport and terminal access roads

- For entrances to parking areas, increase the capacity to store vehicles waiting to enter.

Geometric design alternatives for terminal curbside areas are discussed in section 6.3.

Traffic Operation Alternatives

A study performed by the Port Authority of New York and New Jersey reported that passengers found "information they receive in and around the airport is often confusing, incomplete, too detailed, poorly located and sometimes non-existent." This problem appears to be endemic at airports and is partly a function of the airport's complex changing environment, as well as the unfamiliarity of the majority of patrons.[14]

Improvements in signs can enhance safety and sometimes improve traffic flow through airports. Wayfinding facilities is a critical issue for airports, especially considering the information needs of unfamiliar drivers on a roadway system that serves numerous destinations. Navigational information, static and dynamic displays, and directional and identification signs are all key components of an airport's highway information system. Clearly visible signs should be positioned on roads and in terminal curb areas well before desired destinations to permit drivers to detect, respond, and decide on appropriate driver control actions and execute them safely and efficiently. Signs should be properly lighted for night use. Sign legends should be easily detectable and readable within the available viewing distances. Messages should be concise, command the attention and respect of drivers, and be easily understood. In addition, signs should be clearly visible by approaching motorists during daylight and nighttime ambient conditions. Color coding for unit terminals, airlines, parking facilities, etc., is recommended, particularly for complex terminal areas. The ITE's *Airport Roadway Guide Signs, A Proposed Recommended Practice*[3] can serve as a valuable resource. This document recommends the use of symbolic signs, as shown in figure 6.1-6, for airports with frequent foreign visitors. As noted in the ITE document, standardization of airport sign terminology should not conflict with the *MUTCD* but rather, supplement it. A typical sign plan for a multiterminal airport is shown in figure 6.1-7. General guidelines for providing signs on the airport roadway system are shown as a sidebar.

Because land in the immediate terminal area is often at a premium, some rental car agencies have begun to base vehicles at remote locations and use courtesy vans to shuttle customers to and from the terminal curbside and remote locations. A rule of thumb is that approximately 750 originating passengers are accommodated per rental car ready stall. When rental car pickup and return are close to the terminal curbside, consideration should be given to relocating them to remote areas that are removed from the terminal. Other operational improvement alternatives that can be considered for the terminal curbside area include the following:

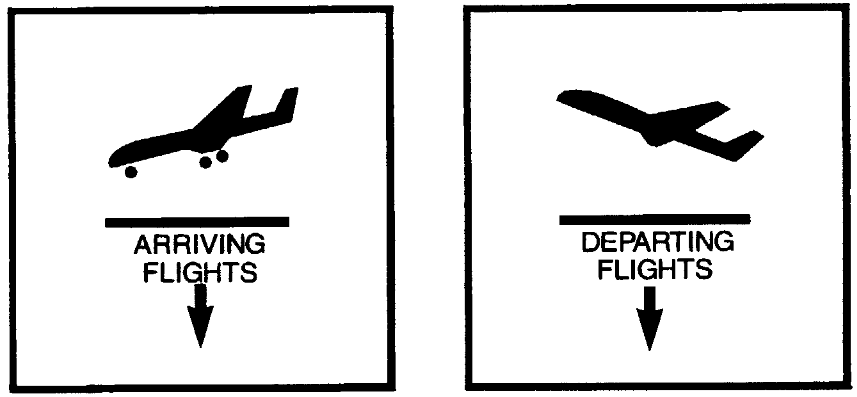

Figure 6.1-6. Highway Signs for Airports With Frequent Foreign Visitors[3]

- Improve delineation, pavement markings, pavement markers, and channelization

- Change the operation of the terminal access and frontage roads to one-way and counter-clockwise

- Implement a sign system that provides drivers with reasonably accurate, real-time data on parking availability (e.g., "Short-Term Lot Full, Use Satellite Lot").

<u>Transportation Enhancement Alternatives</u>

Since the passage of the ISTEA, improvement alternatives that do not improve roadway capacity have been referred to as "transportation enhancements." For airports, typical enhancements include the following:[4]

- Provide covered walkways from public parking lots to entrances of terminal buildings

- Improve markings and lighting of pedestrian routes

- Install or improve shelters for shuttle bus stops

- Improve visibility of signs and markers denoting shuttle stops

- Install "secured" bicycle racks for storage of bicycles used by airport passengers, employees, and visitors

- Improve pedestrian and bicycle trails and walkways, especially those that connect intermodal terminals.

Management of Traffic During Construction

The need to maintain vehicular traffic flow and accommodate pedestrian traffic should not be overlooked when airport roadway physical improvements are implemented. While

Recommended Sequence for Signs on Airport Roadways

1. *Erect airport identification signs that clearly indicate that the patron is on the airport grounds. For larger airports, indicate the distance to the terminal area, so patrons are comfortable in passing ensuing exits to ancillary destinations.*
2. *Direct all traffic not destined to the terminal to other locations, such as hangars, industrial areas, air cargo, airport services and deliveries, administration, hotel, air mail freight, and service roads.*
3. *Direct rental cars, if there is a remote dropoff.*
4. *If there is a remote lot, provide a billboard sign, in a simplified form, indicating the various types of parking facilities at the airport and their relative rates.*
5. *Direct traffic to the remote lot.*
6. *Direct traffic to the terminal(s).*
7. *Indicate the terminal-parking split.*
8. *Indicate the arrival-departure split.*
9. *Direct traffic from the terminal to parking and exit.*

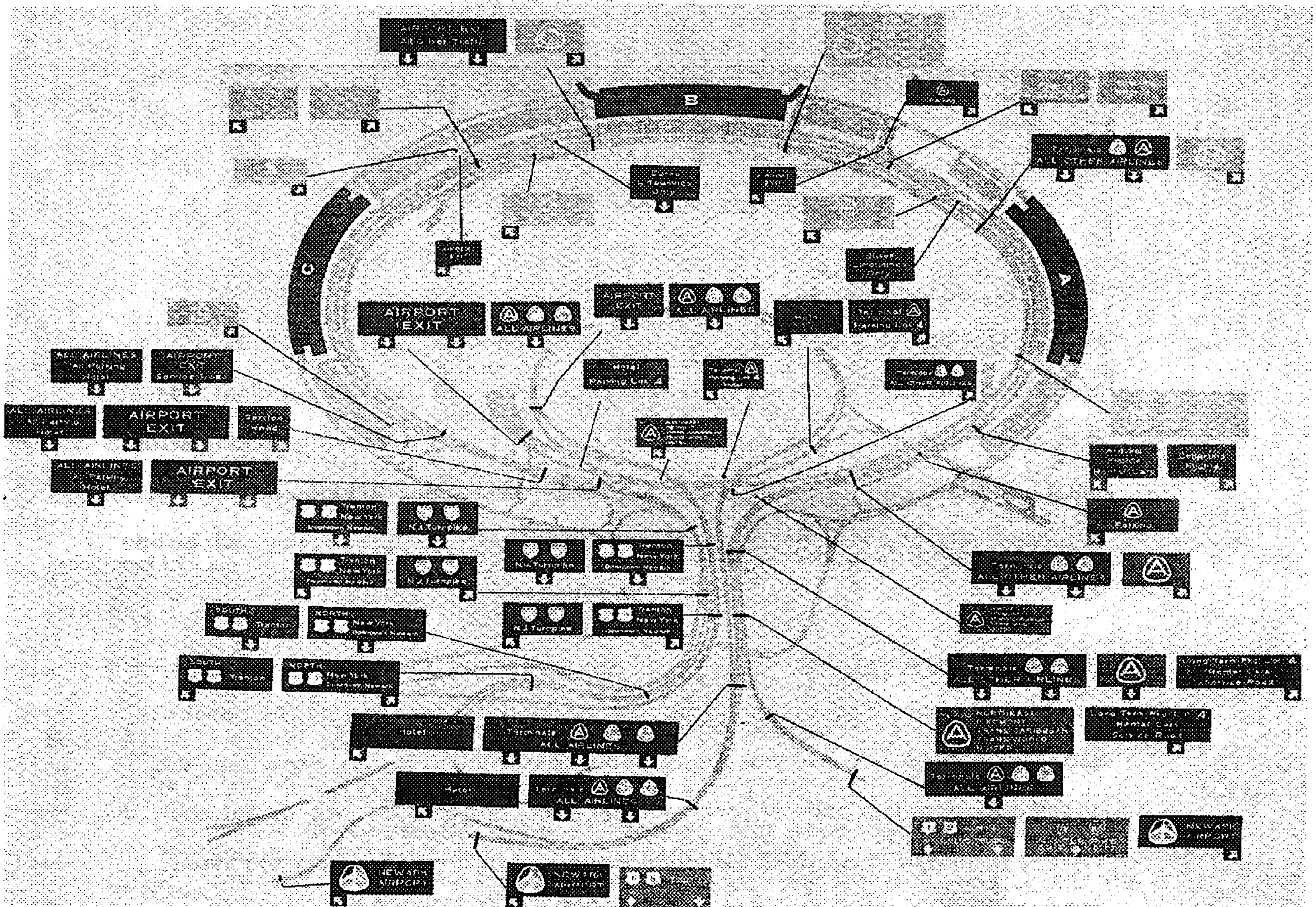

Figure 6.1-7. Typical Sign Plan for a Multiterminal Airport[2]

improved traffic flow may be the result after the construction is completed and the geometric and traffic operational changes have been implemented, adverse effects during construction can be staggering. It is recommended that staging and traffic maintenance plans be developed, reviewed, and approved before the start of any construction that would alter the capacity of airport roadways or reduce curbside capacity. Construction work zone plans should be in conformance with the guidelines and principles presented in the latest revisions of part VI of the *MUTCD*.[1] Two lanes are desired during construction on the approach to the enplaning curbside. Mitigating measures should be considered to provide sufficient curbside capacity during construction, especially if construction must take place during peak seasonal travel periods. In general, the performance characteristics of construction vehicles are much lower than the performance characteristics of other vehicles. Consequently, every effort should be made to segregate construction traffic from other airport-related traffic, especially on critical terminal area access roads, recirculation roads, and terminal frontage roads with limited highway capacity.

6.2 Parking Alternatives

With the increases in air traffic volumes and the high reliance on the automobile as the primary mode of ground transportation to the airport, the demand for more parking capacity at most U.S. airports is growing. Studies of existing parking conditions and projected future parking demand, such as those described in Chapter 5, can identify the need to improve existing and/or future parking facilities at an airport. Because the automobile is the primary access mode to most airports, a sufficient supply and proper allocation of parking spaces are important for convenient airport access. If the analysis of current or projected conditions identifies these parking problems, alternatives can be developed to alleviate them. Generally speaking, options for improving airport parking conditions include the following:

- Space reallocation to match parking demand
- Modifications to parking operations or rates
- Redesign and/or construction of facilities to improve capacity.

Reallocation of Spaces

Airport parking can be allocated for different users (e.g., employees, passengers, rental car drivers), different parking durations (e.g., long term, short term), or different LOS (e.g., self-park, valet). An airport will often have enough total space, but too much may be allocated to one user group and not enough to another. In these situations, it may be necessary to reallocate parking from one use to another. Examples of space reallocation include moving employee lots to provide more public parking or exchanging long-term areas to create more short-term and intermediate facilities. Table 6.2-1 identifies different types of parking space reallocation that can be accomplished at airports, the reasons for reallocating the spaces, and if available, examples of airports where reallocation has been accomplished.

Table 6.2-1. Reallocation of Spaces

Type of Reallocation	Description	Reason	Examples
Moving employee lots to create more public parking.	Conversion of employee lots to long-term/remote parking.	Demand/occupancy studies verify need for more long-term public parking. Employees will more readily accept shuttle service.	(None available)
Exchanging long-term parking for short- and intermediate-term spaces.	Changing the designation of already functional parking areas. In small airports, this could involve moving barriers.	Periodic studies reveal that the short-term/intermediate facilities are consistently operating beyond capacity, whereas the long-term facilities are underused.	Birmingham, AL; Santa Ana, CA; Manchester, NH; Huntsville, AL; Charlotte, NC; Jacksonville, FL; Las Vegas, NV; Portland, OR; Salt Lake City, UT; Newark, NJ
Introducing, increasing, or reducing valet parking.	Attendant picks up, parks and delivers patron's vehicle at or near patron's destination (i.e., the terminal).	Because it is convenient and saves time, valet parking is being introduced or reinstituted at numerous airports. Business people, in particular, prefer and are willing to pay for the convenience and LOS.	<u>Airport</u> <u>Spaces</u> Anchorage, AL 480 Baltimore/ Washington Int'l 958 Burbank, CA 500 Dayton, OH 200 Detroit Metro 150 Minneapolis/St. Paul 439 Washington Dulles 327
Moving rental companies/vehicles to create more public parking.	Return car area (office), service area, and ready car area moved off airport. At the very least, functional support operations can be moved. Patron shuttles are provided by the companies.	To gain more short-term or long-term parking.	(None available)

Methods of Operation

Public parking facilities at airports can be operated using a variety of methods, each of which has advantages and disadvantages. The four methods of operating airport parking facilities are described in table 6.2-2 and include: management contract, concession agreement, self-operation, and combination.

Table 6.2-2. Methods of Parking Operations Used by Airports[15]

Method of Operation	Number of Airports by Size			
	Large	Medium	Small	Total
Management Contract	14	20	19	53
Concession Agreement	2	1	26	29
Self-Operation	6	7	15	28
Total	22	28	60	110

Table 6.2-3 summarizes the methods used to operate airport parking at 110 airports that responded to an AAAE survey. This table illustrates that the concession agreement, while still in vogue at the small airports, is very seldom used at the medium and large airports. During 1993-1994, 48 percent of the airports that responded to the AAAE survey operated public parking facilities through management contracts, and 25 percent assumed responsibility for operating their own facilities.

Further proof of the shift away from the traditional lease or concession agreement to either a management contract or self-operation is demonstrated by another survey. Of the 113 airports that responded to the ACI-NA 1991 Airport Parking Systems Survey,[16] 47 (42 percent) operated with a management contract, 28 (25 percent) operated their own parking facilities, and 36 (33 percent) operated under the once almost-exclusive concession agreement.

A primary reason for this trend is that approximately 10 percent of the gross parking revenues go to the lessee or concessionaire and, as the revenues increase, airport operators would rather keep this significant airport revenue. As an example, the gross parking revenues at San Francisco International have increased from $4 million in 1971 to $34.5 million in 1993. Revenues from parking at three other airports operating their own parking facilities in 1993 were $44,371,000 (at Dallas/Fort Worth); $40,149,544 (at Chicago O'Hare); and $36,915,158 (at Boston Logan). In addition, these revenues are available for immediate use by the airport, rather than its having to wait for up to 60 days for payment from concessionaires or lessees.

The ACI-NA survey identified acceptable methods of payment for public parking at 57 airports. Only four of those airports have machine cash collection capabilities (e.g., pay-on-foot stations in the terminal) and only two accept debit cards, innovations that will certainly be used more frequently as Intermodal Transportation Sytems improve. A number of airports have machine or automatic read capability

Table 6.2-3. Alternative Approaches for Operating Airport Parking[15]

Method	Description	Advantages	Disadvantages	Examples (1993 Dollars)
Management Contract	Airport contracts with professional parking company to operate facilities for management fee plus reimbursement of approved operating expenses. Operator provides all personnel and stipulated services and collects all revenues, which are deposited into an airport bank account. Approximate cost: $50,000/year.	- Places full operational responsibilities with parking company. - Operator's primary concern is not financial but providing services that airport stipulates. - Operating emphasis can be placed on revenue control and labor supervision. - Generally easier to terminate a management contract than to break a lease agreement.	- May not be incentives for managing agent to increase gross revenues or control operating expenses. - Airport is responsible for payment of operating costs but has little direct control over expenses.	- Phoenix Sky Harbor Airport paid $41,675 management fee. - Nashville International has 5-year contract; fee ranging from $44,624 to $60,624/year, including bonus for quality service (i.e., low number of complaints). - KCI pays $50,000/year for personnel only; airport pays all additional operating expenses.
Concession Agreement	Airport leases parking system to outside entity/operator for minimum guarantee plus percentage of gross or net revenues at escalating levels. Could also be leased for percentage of net operating income.	- Operator (lessee) assumes all monetary risks/expenses, which is attractive if airport is seeking to minimize operation involvement (e.g., small hubs) and maximize revenues. - Concessionaire has the most incentive to operate efficiently.	- Emphasis on maximizing profits may de-emphasize customer service. - Airport exerts least control over parking operation. - 10 percent of gross parking income goes directly to concessionaire. - Airport must wait 30-60 days for payments.	- Cincinnati-Northern Kentucky International receives 87.4 percent of gross receipts. - Dayton International receives 91.5 percent. - Louisville-Standford Field receives 90.9 percent. - BWI receives 90 percent of receipts after shuttle bus costs are deducted.

Table 6.2-3. Alternative Approaches for Operating Airport Parking[15]

Method	Description	Advantages	Disadvantages	Examples (1993 Dollars)
Self-Operation	Airport assumes total responsibility for all operating functions, (e.g., day-to-day supervision; staffing, including recruiting and training; revenue collection/auditing; maintenance; insurance; taxes; payroll; etc.). Airport can operate parking services with its own employees and as an extension of its existing services (e.g., utilities, security, maintenance, accounting, administration, etc.).	- Substantial management fee or percentage of gross revenues does not have to be paid to a parking company. - Airport retains immediate use of its own revenues. Airport has most day-to-day control over the parking service.	- Airport staff must be educated on mechanics of a large and complex parking operation. - Airport management must assemble and supervise sizable work force, including money-handling.	- The three airports with the highest annual gross parking revenues, Dallas/Fort Worth ($44,371,000), Chicago O'Hare ($40,149,544), and Boston Logan ($36,915,158), all operate their own parking facilities.
Combination	Can involve any combination of other three approaches. For example, many provisions, terms, and conditions formerly only included in management contracts are now being embodied in concession agreements (e.g., depositing the revenues into the airport's or trustee's bank account on the next business day and specifying staffing of the lanes).	Combination of other three.	Combination of other three.	- Charlotte/Douglas (NC) International operates parking, but contractor provides personnel. - Madison (WI) airport operates parking, except remote facilities which an outside company operates under management contract. - LAX and Cleveland Hopkins employ operators under a hybrid concession/ management contract.

(i.e., a machine reads the ticket and calculates the fee). Many of these fee collection computers are, in turn, linked to a host computer for space information and revenue reporting. Some airports include an on-line license plate inventory system to automatically calculate parking fee if a patron loses a ticket. Automated parking operations should increase as Intermodal Transportation Systems improve.

The ACI-NA survey also included costs for operating public parking facilities at 60 airports. These data are summarized by airport size in Table 6.2-4. The yearly average for all size airports was approximately $1.6 million or $300 per space. The size of the airport and whether the parking is structured or surface are among the factors that affect the operating expenses. These data suggest that the cost of operating public parking facilities at airports with over 2.5 million originations can be very high, ranging from $152 to $1,341 per parking space. Operating expenses decrease at smaller airports.

Parking Rates and Pricing

According to the 1991 ACI-NA survey,maximum daily rates average $15 at large airports, just over $12 at medium airports, and just under $7 at smaller airports.[17] The highest daily maximums are $49 at Chicago Midway and $48 at Newark International. The effect of parking charges as a means of altering the use of parking facilities is discussed in section 6.5 on TDM.

Table 6.2-4. Cost of Operating Airport Parking Facilities[16]

Originating Passengers (Millions)	Number	1990 Operating Expenses (Dollars)			1990 Operating Expenses (Dollars Per Car)		
		Low	High	Median	Low	High	Median
<0.5	14	58,000	4,145,000	206,671	56	728	169
0.5 -1.0	9	83,477	1,381,053	386,852	26	462	196
1.0 - 2.5	15	99,375	2,531,988	923,000	12	803	238
2.5 - 5.0	10	1,211,720	7,312,836	2,687,603	152	785	423
>5.0	12	1,400,000	9,289,701	2,218,535	125	1,341	302

Alternative Types of Parking Facilities

After the capacity limitations of on-airport parking are reached, storage of automobiles at metropolitan airports can lead to many problems. Those seeking a parking place are forced to recirculate, double-park along terminal frontage, or even park along the side of remote airport roads. Recirculation reduces roadway capacity, results in passenger delays, and decreases

LOS. Airport operators must find alternatives to new on-airport surface parking to satisfy parking demand.

Structured Parking

Most travelers driving to the airport prefer to park as close to the terminal as possible. Unexpected difficulties trying to find a parking space or an unplanned shuttle trip from a distant location raise the anxiety level of most travelers. Constructing a multilevel parking structure is a feasible solution to the ever-increasing demand for airport parking. These multilevel facilities should be constructed as close as possible to the passenger terminals and should accommodate both short- and long-term parking. Parking garages enable airports to raise service level standards by saving passengers and others considerable time, reducing walking distances, and affording protection from the weather (especially if an enclosed pedestrian bridge or walkway is provided). A multilevel parking structure also enables airports to conserve valuable land and park many more vehicles within a given area. Construction of tiered parking facilities should be preceded by a feasibility study to document such factors as parking demand, size of the structure, site selection, ingress and egress, construction costs, net operating income, and debt service coverage.

Off-Airport Facilities

Off-airport parking offers one solution to the need for additional airport parking facilities, but usually with varying results. Drivers hesitate to use off-airport parking in the hopes of obtaining closer in spaces. Off-airport parking is often thought of as a spillover resulting from insufficient on-airport capacity. If they cannot find on-airport parking, drivers return to an off-airport facility and, in the process, use both inbound and outbound terminal roadway capacity.

Among the advantages of off-airport parking are reduced vehicle trips to the airport, reduced on-airport parking demand, and the potential for improved air quality. Apparent disadvantages are loss of airport parking revenues and inconvenience to airport users. Long-term public parking and employee parking with shuttle transportation are the most suitable types of off-airport parking.

Technical studies should be made of proposed off-airport parking facilities to determine such factors as demand characteristics, transportation shuttle needs, and financing requirements for land, construction, and operations. Changeable message signs, HAR, and other traveler information systems, discussed in section 6.7, can be used to encourage passengers to enter off-airport parking before entering the airport.

Remote Employee Parking

Employees and other nonpassengers usually are permitted to park close to their work areas or destinations, unless these areas are located near the terminal buildings. However, if space for parking cannot be located near the work location, remote parking facilities with shuttle service to the work areas must be provided. Remote off-airport parking for employees may be necessary if on-airport capacity is not available. It has been established that employees will more readily accept remote parking than airport passengers for the following reasons:

- Uncertainty of shuttle bus schedules is less critical to employees
- Employees are not frustrated by the luggage handling from automobile to shuttle bus to terminal, as well as the anxiety of making flights.

6.3 Curbside Capacity Improvements[17]

One of the most valuable, often used, and congested components of an airport access system is terminal curbside. This area provides the most convenient location for passengers to transfer between an airport terminal building and ground access. It is used by automobiles, buses, taxis, limousines, courtesy vehicles, and other rubber-tired modes to pickup and discharge passengers that originate or terminate their trips at the airport.

Congestion at terminal curbsides can be reduced by better managing the use of available curb length or by modifying the physical layout of curbside facilities (e.g., providing a longer curbside). Terminal curb analysis and the identification of alternative improvements must be performed with an understanding of the difference between the behavior patterns and needs of enplaning and deplaning passengers.

The arrival times of passengers originating their trips at an airport will be spread over a significant period of time before a flight's departure. The arrival times of these passengers will depend on the activities that they need to perform at the airport (e.g., ticketing, baggage check, check in), the types of flights they are taking (e.g., international or domestic), the purposes of their trips, the modes they used to get to the airport, and personal preferences. The ground access vehicle used by enplaning passengers, whether it is low occupancy (e.g., private auto, taxi) or high occupancy (e.g, express bus), will normally only remain at the curbside while the passengers disembark.

The arrival times at the terminal curbside of passengers who terminate their trips at an airport are more subject to peaks, because an entire flight deplanes and passengers want to leave the airport as soon as possible. Flight arrival times, the time required to deplane, the time required to retrieve baggage, and the time required to reach the curbside from the airplane are not totally predictable. Drivers of vehicles picking up passengers at the terminal curb are not able to predict the exact time that a deplaning passenger will reach the curbside. Vehicles picking up terminating passengers tend to wait at the curbside, if they can, for longer periods of time, and passengers tend to get to the curbside at the same time, thus deplaning passenger operations are generally more demanding of curbside resources than enplaning operations. Alternatives to increase curbside capacity and reduce curbside congestion usually are driven by the needs of deplaning passengers.

Curbside Operations

The major characteristics influencing the organization and management of terminal building curbsides are:

- *Number and type of ground transportation access modes* (i.e., the number of private vehicles, taxis, buses, courtesy vehicles, vans, and limousines that are driven along the curbside each day). The number of private vehicles using a curbside may vary if convenient, short-term parking is available (drivers may choose to park rather than use the curbside).

- *Curbside dwell time* (i.e., the length of time vehicles remain at the curbside). Dwell times vary depending on whether drivers are prohibited from remaining at the curbside unless passengers are actively boarding or alighting a vehicle. Dwell times for buses, vans, and limousines are influenced by the number of passengers and bags being picked up or dropped off and by the time required for vehicle maneuvering. Because of the greater number of passengers and bags per vehicle, buses, limousines, and vans remain at the curbsides for longer periods of time.

Each type of ground transportation access mode has a different circulation pattern and distinct operational need at the curbside. These patterns and needs should be considered when evaluating possible curbside management measures. Because the primary objective of all airport operations is to provide a high level of convenience and maintain safety for passengers and vehicles, minimizing the conflict between the two and ensuring a level of safety for pedestrians should also be considered. The following paragraphs describe the key curbside operational characteristics of each of the primary access modes.

Private Vehicle Operations

Drivers picking up deplaning passengers often arrive early and remain longer at the curbside. Private vehicle drivers usually attempt to stop as near as possible to the doorways serving their airlines. Drivers can be encouraged to wait for deplaning passengers in the short-term parking areas, if they are aware that spaces are available.

Taxi Operations

Deplaning passengers typically arrive at the curbside in large groups, reflecting aircraft arrivals. At larger airports that have taxi dispatchers, the dispatchers learn through experience which flights generate a need for many taxis. To respond to these surges in deplaning passengers, groups of taxis are dispatched from the taxi pool to the terminal curbside to wait for customers, minimizing customer waiting time. (Taxi drivers should also be prohibited from leaving their vehicles unattended at the curbsides.)

Curbside space for the operation of taxis is allocated for: (1) taxi stands large enough to accommodate many taxis at one time, (2) clearly designated passenger waiting areas (to enable taxi dispatchers to estimate the number of taxis required), and capacity and reduce curbside congestion usually are driven by the needs of deplaning passengers.

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Curbside space for the operation of taxis is allocated for: (1) taxi stands large enough to accommodate many taxis at one time, (2) clearly designated passenger waiting areas (to enable taxi dispatchers to estimate the number of taxis required), and

(3) the queue of newly arrived vehicles waiting to enter the taxi stand.

Curbside space not appropriate for use by other services (e.g., space not located near terminal doors, space on a roadway curve) can be used to store taxi queues, or separate taxi staging areas can be provided away from the terminal building.

Scheduled Services

Scheduled services often have many buses and vans arriving at (or departing from) the same curbside area simultaneously. Adequate curbside space must be reserved to accommodate these nonuniform arrival patterns and to prevent the backup of buses waiting to gain access to the curbside.

To allow for proper operations, vertical clearances of at least 13 feet should be provided for intercity buses and 11 feet for other full-size buses. Some airports provide holding lots for commercial vehicles that allow drivers and vehicles to wait between runs.

Nonscheduled Limousine and Charter Bus Operations

Limousine services include shared-ride services (vans or sedans) and private services (prearranged chauffeured or luxury limousines). Luxury limousine drivers typically meet their customers at the gate, while charter bus operators that serve larger passenger groups often provide a host or greeter to assemble the group (and their baggage) before the bus arrives. Shared-ride services operate more like taxis, where the driver, a dispatcher, or starter assembles a passenger group. At some airports, drivers compete to solicit the same passenger. At other airports, some shared-ride operators have kiosks or ticket counters in the baggage claim area that they use to form passenger groups. To improve curbside operations, drivers of private limousines or charter buses should be prohibited from leaving the limousine hold area (a remote waiting area) until their customers' flights have arrived. Drivers of all limousines and charter buses should be required to remain with their vehicle at the curbsides and should not be allowed to enter the terminal to greet arriving customers. The curbside areas assigned to limousines should be positioned so that drivers and customers can find one another.

Courtesy Vehicle Operations

Providers of courtesy vehicle services, including hotels, on- and off-airport rental car agencies, and the off-airport parking lots, use a variety of vehicle sizes, including full- and mid-size buses. The vehicle drivers may attempt to respond to hailing by customers, even if they stop in areas reserved for other services or double-park; therefore, it is essential to allocate curbside space for passengers waiting for courtesy vehicles. Shelters are useful at these locations and often contain courtesy phones to supplement those found in the baggage claim area.

Curbside Management Measures

Better management of terminal curbside is an effective approach to improving curbside operations. Most measures require little capital investment and can be implemented in under 3 years, many in under a year. Improved management of existing terminal curb space should usually be evaluated as a means of solving a problem before construction of additional curb space is considered.

Management of the terminal curbsides should be: (1) flexible enough to respond to changes, (2) capable of accommodating the operational requirements of each type of vehicle and the unique characteristics of the airport, and (3) integrated with other ground transportation management measures.

Curbside management needs to be flexible to respond to (and, if possible, anticipate) changing requirements and operating patterns, including changes in:

- The number of vehicles, passengers, and types of services using the curbside (caused by changes in parking availability, mode choice)
- Airline passenger volumes (hourly, daily, and seasonal peaks)
- Airline operations (entry or departure of airline companies, promotional fares, delayed flights, etc.)

Actions that influence the operation of one component of the airport's ground transportation system (e.g., curbside areas, access and circulation roadways, parking facilities, and interterminal circulation buses) can affect other components of the system. For example, ensuring the availability of short-term parking spaces can improve curbside operations.

<u>Objectives of Curbside Management</u>

Curbside management measures should be considered in the context of the ways in which they affect the following general objectives for curbside operations and control:

- Facilitate the efficient movement of passengers and vehicles to and from the curbside areas (i.e., minimize dwell times)
- Provide a safe environment for pedestrians and vehicles
- Provide for the operational needs of the various ground transportation modes and minimize the conflicts between these modes (e.g, private vehicles parking in bus stops)
- Minimize congestion of curbsides and adjoining roadways
- Clearly identify, to passengers and drivers, the curbside designations for each ground transportation access mode
- Ensure that passengers arriving at the curbside are aware of the available choices of ground transportation options.

Curbside management can improve the operations, efficiency, and passenger service level of the airport, but it cannot significantly affect the modes of transportation that passengers choose. In other words, curbside management measures have limited influence on the decisions of passengers who have selected their travel modes before reaching the curbside (e.g., those passengers who have made reservations for rental cars or limousines, expect to be picked up in private vehicles, or have left their vehicles parked at the airport). In addition, curbside operations do not affect the key measures influencing passenger travel mode choice decisions — the reliability, convenience, availability, and comfort of the various ground transportation operations.

There are two basic categories of curbside management measures: curbside space allocation and curbside enforcement and traffic control.

Table 6.3-1 identifies measures that improve the use of terminal curbside space. These measures allocate curb space to the most appropriate users, reduce the number of vehicles at the curb, improve operations at the curb, and facilitate enforcement. Table 6.3-1 describes seven measures, their benefits, some locations where they are used, and the length of time it should take to implement each measure.

Curbside Enforcement and Traffic Control

Curbside enforcement procedures can be established to ensure the proper operation of curbside areas and to respond to unusual conditions (e.g., overflow situations during holiday

Table 6.3-1. Curbside Space Allocation Measures

Measure	Description	Benefits	Locations Used	Years To Implement
Develop rationale for curbside space allocation.	Multipassenger and private vehicles are allocated space in accordance with objectives. Must recognize/passenger safety, physical constraints, different operational requirements, unique characteristics of airport.	Provides framework for allocating curbside based on unique needs of airport.	Boston Logan	< 1
Separate private and commercial vehicles.	Passengers and private vehicles recognize that pickups and dropoffs are prohibited where multipassenger vehicles are assigned a specific curbside area.	With physical separation, curbside enforcement is more effective, and commercial vehicle operations are improved. Separation ensures a level of safety for pedestrians and vehicles.	Dulles International Washington National Minneapolis-St. Paul Portland, OR	1-3
Relocate activities.	Relocate vehicles that do not have immediate need at curbside to other locations.	Reduces number of vehicles waiting at curbside.	—	<1
Provide clear signs and curbside delineation.	Regulatory signs are needed to indicate traffic rules and to clearly define curbside areas allocated for each type of vehicle.	Curbside management and enforcement can be assisted by traffic signs that are easily recognized and understood by motorists and pedestrians.	—	1-3
Install flight information displays.	Video monitors displaying flight information can be installed at deplaning curbsides.	Actual arrival times and status of inbound flights are indicated.	Massport has installed displays at Terminal C and the limousine hold area.	1-3
Provide alternative passenger pickup areas for private vehicles.	Alternative boarding areas could be provided and linked to the terminal buildings via a people-mover system.	Relieves curbside demand at central curbside area.	Newark Seattle-Tacoma Portland	1-3+

Provide angled pickup spaces for buses and shuttle vehicles.	Angled curbside spaces can be provided on roadways with adequate widths, rather than having vehicles stop along curbside in a bumper-to-bumper alignment.	Allows more buses and vans to stop, reducing passenger walking distances; aids enforcement and discourages double-parking; reduces maneuvering time for large vehicles.	Hartsfield Atlanta Newark Las Vegas Orlando Portland Tampa	>3

periods). Curbside enforcement can be accomplished by police, officers employed by the police, ground transportation supervisors and agents, and civilian attendants and ticket writers. Enforcement staff should have the authority to issue legally binding tickets.

Enplaning and deplaning curbsides are often separated. The degree of enforcement required on deplaning curbsides is greater than on enplaning curbsides because of differences in driver behavior. Drivers dropping off passengers will typically drive away as soon as the passenger enters the terminal. Thus, on the enplaning curbside, some enforcement is required to discourage double-parking, but less action by enforcement staff is required to discourage unattended vehicles.

Conversely, drivers picking up passengers prefer to wait at the curbside (even if they are double-parked) until the passenger arrives. These drivers will remain at the curbside unless there is active enforcement to discourage them from doing so (e.g., prohibiting waiting at the curbside unless a vehicle is in the process of picking up passengers). Similarly, active enforcement is needed on the deplaning curbside to ensure that commercial vehicles are not left unattended. Double-parked vehicles interrupt the flow of traffic and restrict the maneuvering of HOVs into and out of the curbside area.

Table 6.3-2 provides information similar to that in table 6.3-1 for improving curbside enforcement and traffic control. Most curbside enforcement and traffic control measures can be implemented in under a year. These measures, used in conjunction with measures that improve the use of curb space, will allow an airport operator to maximize the benefits derived from existing terminal curb space.

Table 6.3-2. Curbside Enforcement and Traffic Control Measures

Measure	Description	Benefits
Enforce "no parking" and "no stopping" prohibitions.	Prohibits excessive dwell time, unattended vehicles, private vehicles stopping in reserved areas, and double-parking.	Reduces amount of stopped curbside traffic to allow for better traffic circulation.
Develop effective communication between enforcement staff and management.	Required to ensure effective communication among airport management, enforcement staff, taxi and limo dispatchers, and commercial ground transportation operators to ensure that vehicles are available when needed but are not causing congestion or backup when not needed.	Allows individuals to discuss opportunities for improving curbside management.
Use taxi pools and limousine hold area to restrict flow of curbside traffic.	If the terminal at which their passengers are arriving is busy, vehicles can be retained in a hold area, either off-site or away from the congestion, until curbside space is available.	Alleviates backups and congestion and improves curbside operations.
Establish procedures and regulations for commercial vehicles.	Operators and drivers of all vehicles are required to comply with airport's rules and regulations.	Ensures proper operation of curbside areas.
Station tow trucks at curbsides.	Presence of uniformed police or civilian enforcement along curbside areas will remind drivers to obey curbside regulations. Have tow trucks drive along curbsides during peak hours.	Encourages drivers to obey posted regulations prohibiting unattended or illegally parked vehicles.

Curbside Construction[18]

Terminal curbside problems may be so severe that they cannot be solved by better management and enforcement alone. It may be necessary to provide additional terminal curb space to accommodate access needs. Additional curb space can be provided in several ways, some of which are only appropriate when implemented with the construction of a new terminal facility or parking garage or reconstruction of existing facilities. Additional curb space can be provided through:

- Horizontal curbside separation
- Vertical curbside separation
- Supplemental curbside areas.

An analysis of the terminal design of over 100 American airports of different sizes was performed to determine a relationship between curbside configuration and passenger originations. The results of this analysis are shown in

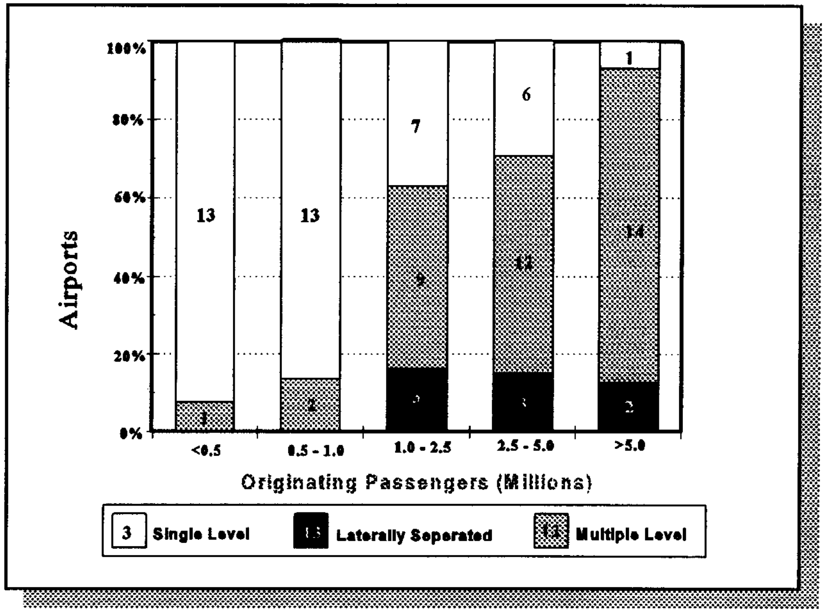

Figure 6.3-1. Airport Terminal Designs

figure 6.3-1. This analysis found that most American airports with fewer than 1 million originations per year have single-level terminals and, as originations increase, the proportion of airports with multiple-level terminals and roadways increases. Over 95 percent of the airports with fewer than 1 million originating passengers a year provided curb space using a single-level terminal building. Almost 40 percent of the airports with 1 to 2½ million originations have single-level terminals. Only 25 percent of the airports with 2 ½ to 5 million originations and fewer than 5 percent of the airports with over 5 million originations have single-level terminals. This analysis also noted that 40 percent of the airports with fewer than 500,000 originations per year provide multiple curbsides through horizontal separation and supplemental curbside areas. This increases to over 60 percent of the airports with more than 5 million originations. Some airports, such as Boston Logan,[19] have multiple curbside and terminal configurations at different terminals.

This section provides brief descriptions of alternatives for providing terminal curb space at airports. Examples of the terminal and curbside configurations used by different American airports are also provided.

Horizontal Curbside Separation

When increasing demands warrant and where roadway width and the absence of physical obstructions (e.g., parking garages) permit, the terminal curbside roadway can be widened to provide a second (or even third) parallel curbside with a raised center island for passenger pickup or dropoff.

An alternative to the center-island curbside is the pull-through configuration illustrated in figure 6.3-2. This configuration, which is used at Lambert-St. Louis International Airport on the upper-level departure roadway, provides pull-through passenger dropoff spaces. Pull-through spaces allow for more parking spaces per linear foot of terminal building frontage than do parallel parking spaces, but they require a minimum roadway width equivalent to about four traffic lanes.

Horizontal separation of deplaning curbside roadways is shown in figure 6.3-3. This configuration, as used at Portland

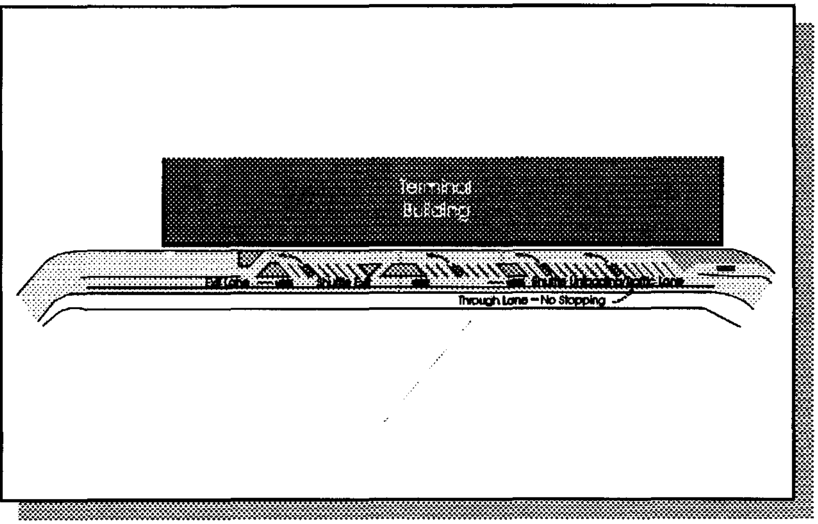

Figure 6.3-2. Use of Pull-Through Passenger Dropoff Spaces

International Airport, provides for passenger pickup along three separate roadways at the deplaning (baggage claim) level. Starting closest to the terminal building, an "inner" roadway provides curbside area for private vehicles, and the next "outer" roadway provides about 30 angled short-term parking stalls (controlled by meters) for private vehicles and a taxi pickup lane. The outermost lanes consist of a commercial vehicle roadway with angled parking stalls and curbside for courtesy vans, scheduled buses/vans, charter buses, and chauffeured limousines.

Minneapolis-St. Paul International Airport will also provide passenger pickup along three arrival-level roadways when planned commercial roadway facilities are completed in 1996. With this plan, the curbside adjacent to the terminal building will be reserved for private vehicles; the middle roadway will be reserved for taxis, limousines, and courtesy vehicles; and the outermost roadway, located within the adjacent parking structure, will provide curbside areas for scheduled buses and vans, as well as a taxi staging area. Passengers will use an underground passageway to go to the commercial vehicle roadways.

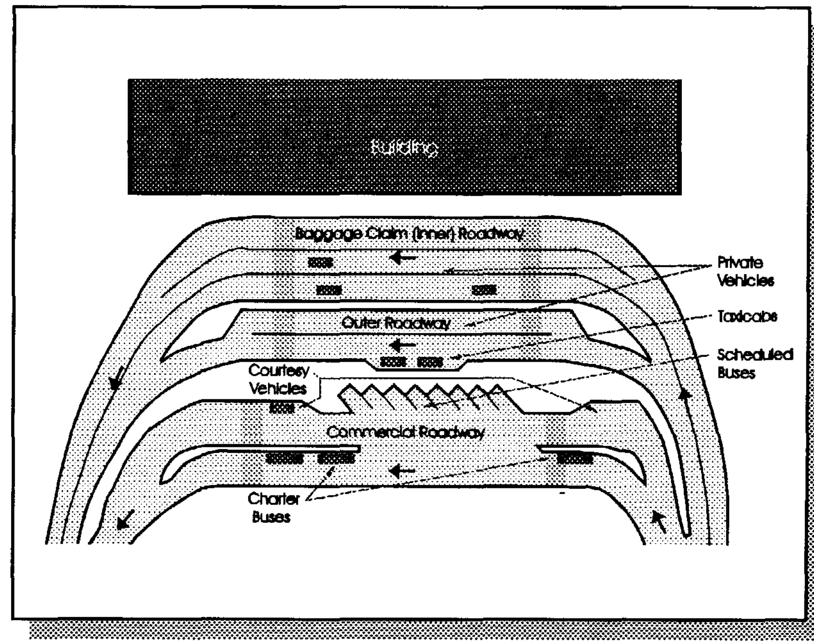

Figure 6.3-3. Horizontal Separation of Deplaning Curbside Roadways

Issues to consider when implementing a center-island or pull-through curbside design include: (1) pedestrian safety (pedestrians must cross the inner roadway), (2) enforcement of curbside usage (restricting private vehicles from areas designated for commercial vehicle use), and (3) passenger convenience (longer walking distances, lack of porter service at the center island).

Another approach to vertical curbside separation is to provide laterally separated ticketing and baggage claim facilities, as illustrated in 6.3-4. At McCarran (Las Vegas), Philadelphia, and Greater Cincinnati International airports, passenger ticketing and baggage claim facilities are located in separate, laterally spaced buildings with enplaning and deplaning curbside frontage areas provided at the same level. Both sides

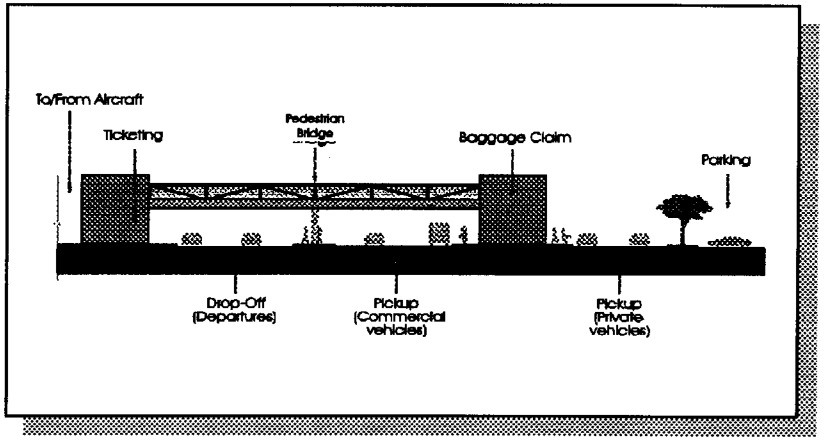

Figure 6.3-4. Laterally Separated Ticketing and Baggage Claim Facilities

of the baggage claim building are used for passenger pickup; one side is reserved for commercial vehicles and the other side, for private automobiles.

Vertical Curbside Separation

As shown in figure 6.3-1, most larger American airports vertically separate departing and arriving activities and the associated curbsides. This configuration is illustrated in figure 6.3-5. At several airports, a third or fourth curbside level has been provided. For example, at Orlando International Airport, two deplaning roadways are provided for passenger pickup on two elevations — one reserved for private vehicles, taxis, and concession limousines and another for other commercial vehicles (e.g., courtesy vehicles, scheduled buses, and other limousines). The commercial vehicle lanes consist of a curbside reserved for courtesy vehicles, scheduled buses, and limousines and about 44 angled parking stalls, each large enough for one bus or two vans.

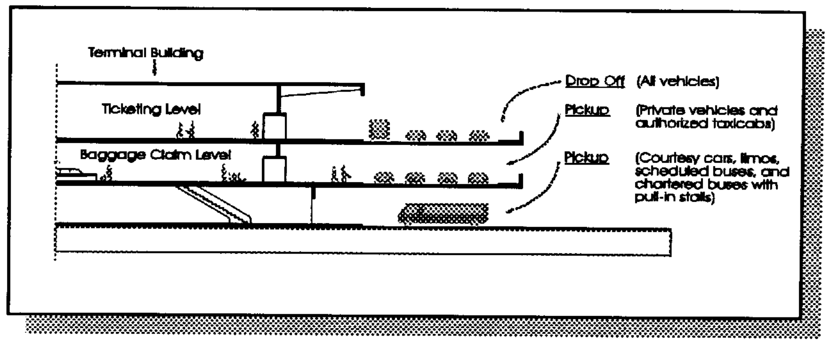

Figure 6.3-5. Vertical Separation of Ticketing and Baggage Claim Curbside Roadways

Other major airports with multilevel curbsides include Pittsburgh and Denver International airports. At Pittsburgh, the east and west sides of the landside terminal building are served by two-level curbsides — one level for passenger dropoff and the other for passenger pickup. The east side is reserved for commercial vehicles and the west side is reserved for private vehicles. At Denver, three-level curbsides are provided on the east and west sides of the landside terminal building. The upper level is for private vehicle passenger dropoff, the middle level is for commercial vehicle passenger pickup and dropoff, and the lower level is for private vehicle passenger pickup.

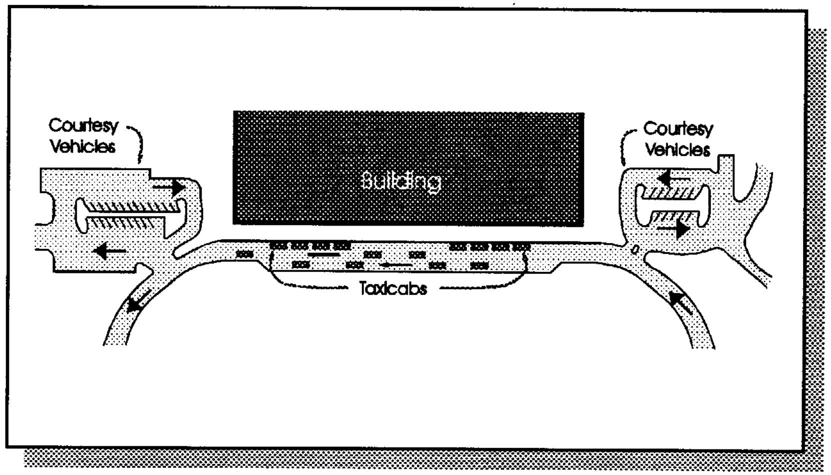

Figure 6.3-6. Additional Passenger Pickup Areas at Ends of Terminals

Supplemental Curbside Areas

Supplemental passenger pickup areas for commercial vehicles are often provided in facilities adjacent to the terminal building, either in surface parking lots or parking structures or elsewhere on the airport in "ground transportation centers."

A conceptual drawing showing an example of additional passenger pickup areas at the ends of the terminal building is shown in figure 6.3-6. At Tampa International Airport, four surface lots located at the deplaning level are provided for all commercial vehicle passenger pickups (except taxi patrons). Each of these "quad lots" contains 17 angled pull-in stalls and a parallel curbside. Commercial vehicles enter and exit the quad lots using roadways that bypass the arrival-level roadway used by private vehicles.

Another example of a supplemental curbside area for commercial vehicle passenger pickup is illustrated in figure 6.3-7. This curbside configuration, as it is provided at Hartsfield Atlanta International Airport, provides a surface lot located at the western end of the passenger terminal for commercial vehicle passenger pickups. The Hartsfield commercial vehicle area has 13 angled, pull-in stalls for use by scheduled buses, 22 angled stalls for courtesy vans, and 2 parallel curbsides for taxis and on-airport rental car vans. Passenger amenities can also be provided, including canopied shelters for use by passengers waiting for scheduled buses or courtesy vans and large signs above the angled berths indicating the destinations of the scheduled buses.

At Newark International Airport, courtyards between the terminal buildings are used by courtesy vehicles and scheduled buses for passenger pickup. Courtesy vehicles park parallel to the curbside and scheduled buses park in angled stalls. Windscreens and canopies provide shelter for waiting passengers.

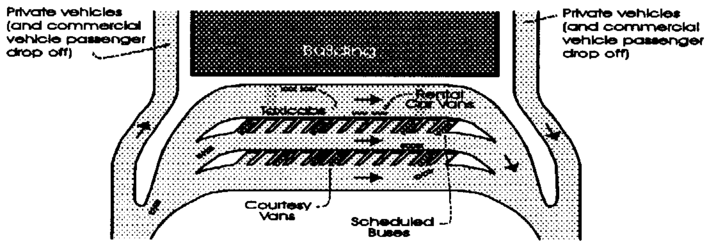

Figure 6.3-7. Supplemental Curbside Area for Commercial Vehicle Passenger Pickup

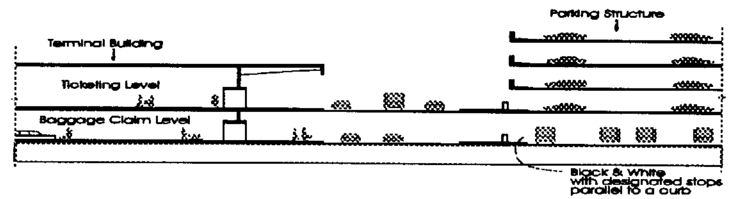

Figure 6.3-8. Additional Pickup Area Located in Parking Structure

Commercial ground transportation facilities can be provided within parking structures or lots adjacent to the terminal building, as illustrated in figure 6.3-8. For example, at Seattle-Tacoma International Airport, the third level of the parking structure includes: (1) a roadway and parallel curbside for courtesy vehicle passenger pickup and dropoff and (2) a metered parking area with 1,000 spaces for use by private vehicles. Pedestrians use an elevated connecting walkway to walk between the parking structure and the terminal building. Commercial vehicle pickup areas located on the grade level of multilevel parking structures are also provided at New Orleans International, Indianapolis International, and Houston Hobby airports.

The operators of San Francisco, Los Angeles, and Miami International airports are planning large, centralized "ground transportation centers," located at a site remote from the passenger terminal that will provide pickup and dropoff areas for passengers traveling in commercial vehicles. These facilities are designed to accommodate and encourage the use of commercial vehicles by providing a high LOS for the passenger. To provide a high LOS, these facilities could include such amenities as airline ticketing and baggage check in facilities and concessions. Rapid and convenient transfer between the ground transportation center and the terminal building and airline gates is necessary to promote the attractiveness of these centers. At these three airports, automated people-movers are planned to link the ground transportation centers with the terminal buildings and key airport employment centers and with local and/or commuter rail systems.

6.4 HOV Modes of Ground Access

In the airport environment, several types of shared-ride modes of transportation are typically available, including public transit, interterminal, and parking shuttles; taxis; door-to-door shared-ride vans; courtesy vehicles; charter buses; prearranged services; and at some airports, fixed-rail transit. This section describes rubber-tired and fixed-rail transit alternatives to the private automobile. It also profiles the use of different modes for access to different size airports and describes the characteristics of alternative modes.

General Planning and Design Considerations for Successful Airport Access Modes

While transit modes may vary in terms of sponsorship (e.g., public transit, airport- or privately sponsored transportation) and operational characteristics, providing high levels of passenger service should be a priority for all shared-ride services. A survey was performed at Boston's Logan International Airport to determine the importance of selected HOV ground transportation characteristics. This survey identified service reliability (always on time), travel time equaling the automobile, a guaranteed seat, and easy access as the most important characteristics.[20] A study performed for the Port Authority of New York and New Jersey identified the characteristics of trips that might affect a traveler's mode choice.[21] These characteristics are summarized in table 6.4-1. A number of planning and design issues should be considered when planning for alternative airport ground transportation services. Attention to these issues will enhance the attractiveness of access alternatives to airport passengers, visitors, and employees. The service and operational issues that should be considered when designing HOV services include:

- Maximizing passenger level of convenience and comfort (e.g., vehicle seating configuration and seating capacity; baggage storage space; the number, width, and height of vehicle doors and steps; passenger shelter amenities; speed and reliability of service)
- Certainty of travel time (reliability), which is more important than travel time
- Minimizing the frequency of stops, necessary transfers, and dwell times
- Identifying operational constraints that may affect passenger LOS (e.g., congestion on access roadways and at major intersections, shared right-of-way on local streets or freeways, reserved curb space)
- Considering potential passenger traffic characteristics (e.g., the volumes and locations associated with peak, hourly, and daily ridership; service coverage area; socio-economic characteristics). By understanding the characteristics of potential ridership, operators may plan for services efficiently and effectively (e.g., providing express, dedicated vehicles to serve employees or passengers).
- Developing desired performance measures (e.g., passengers per hour, vehicles per hour, minimum headway)

- Establishing operating procedures, including information regarding passenger pickup and dropoff, driver and vehicle requirements, and staging areas

- Identifying compliance and operational review procedures (e.g., vehicle safety requirements, permitting procedures, schedule adherence, monitoring of excessive circuits or dwell times)

- Considering the needs of disabled passengers in providing services (e.g., lift-equipped vehicles, audio information systems or driver announcements of stops, color and size of passenger wayfinding signs and symbols

- Determining the feasibility of establishing programs to set priorities for HOV travel throughout the region. Coordinate efforts with local and regional transit agencies, MPOs, and State and local transportation agencies to implement priority measures for HOVs, including reserved lanes and ramps, signal pre-emption or special signal phases, central or outlying transfer, and park-and-ride-terminals.

- Identifying fare collection methods and procedures that minimize passenger delay.

A survey performed at Boston's Logan International Airport identified service reliability (always on time), equal travel time to the automobile, a guaranteed seat, and easy access as the most important characteristics of an airport access mode.

Rubber-Tired Transit Service Options

A number of different types of rubber-tired transit services are provided at airports throughout the United States. Each airport is unique, and the type of transit service best suited for a specific airport depends on a number of factors. Likewise, each rubber-tired transit service has different characteristics and market applicability. These services can either be publicly sponsored (e.g., provided by a local or regional transit authority), sponsored by the airport, or privately sponsored. Rubber-tired services, along with their characteristics, market applicability, and examples of where they are used, are discussed in this section.

Table 6.4-1. Characteristics of Trips That Might Affect New York AGT Choice[22]

Passenger or Employee Trip Characteristic	Potential Impact on Behavior
Number of people in travel party	More people in party encourages travel modes that charge by the group (i.e., taxi) and discourages modes that charge by the person (i.e., AGT).
Location of the trip end of the airport access trip away from the airport	People located close to AGT stations, or in locations where the AGT offers significant performance advantages relative to existing travel modes to the airports, are more likely to choose the AGT.
Trip purpose	People making business trips are likely to value reliability and travel time more than people making nonbusiness trips. In addition, they may be less likely than people making nonbusiness trips to have luggage. Thus, relative to nonbusiness passengers, business passengers will favor modes that offer fast, reliable trips and be less concerned about modes that offer especially efficient luggage handling. Nonbusiness passengers may be more sensitive to cost differentials than business passengers.
Current mode of access to the airport	People using more expensive taxi and auto park modes may value their time and the convenience of these modes highly. People currently being dropped off or using rental cars may have special travel needs that the AGT cannot satisfy. People currently using express bus or transit may be particularly likely to use the AGT services.
Airport used	People using JFK are more likely to be catching long-haul flights, where alternative flights are less likely to be available. Thus, they may be inclined to choose airport access modes that have high reliability.
Length of time passengers plan to be away from home	People staying away from home longer are likely to have more luggage and face higher parking charges at the airports. Thus, these people may favor modes that handle luggage efficiently and enable them to avoid driving and parking at the airports.

> **Goals**
>
> Four goals were developed for a recent study to improve taxi operations at Washington National Airport. These goals, which are probably just as applicable to any rubber-tired commercial service provided at an airport, are:
>
> 1. Provide an acceptable level of service to the traveling public that use taxis.
>
> 2. Minimize operation and maintenance costs associated with taxi operations.
>
> 3. Minimize the impacts to other operations at the Airport and in the vicinity of the Airport.
>
> 4. Provide the opportunity for taxi drivers servicing the Airport to make a good living.[22]

<u>Publicly Sponsored and Airport-Sponsored Services</u>

Public transit and airport-provided services are available at many airports. These services are described in table 6.4-2.

Traditional Public Bus Services

These services include all forms of regularly scheduled public transportation, including local and regional bus routes operated by public transit agencies. Transit agencies usually offer a designated stop at the airport along a multiple-stop route (e.g., Suntran service at Tucson International Airport). Depending on demand, funding availability, and project priority, some transit agencies may provide express or semi-express routes to the airport (e.g., nonstop or limited-stop service between the airport and a nearby rail station or major activity center), as are currently provided from Portland International Airport to downtown Portland.

The primary service objective for multiple-stop routes serving the airport is to provide scheduled service to numerous residential and commercial areas, usually located along a major artery. The needs of the airport passenger, therefore, are considered equally as important as the needs of the general public passenger using the route. These routes, because of frequency of stops and associated travel times, are usually less attractive to airport passengers and visitors than to airport employees living along the route, who may elect to use this mode for cost or other reasons.

On-Airport Shuttle Services

Airport operators may provide shuttle services to transport passengers and employees between public or employee parking lots and passenger terminal buildings. Shuttle services are typically provided when walking distances to the terminals from the parking lots or between terminals are greater than 600 to 1,000 feet or a distance established by the airport operator. At Boston, Los Angeles, and Philadelphia International airports, shuttle services are provided to serve remotely located public and employee parking lots and multiple terminals.

Table 6.4-2. Publicly Sponsored and Airport-Sponsored Services

Type of Service	Traditional Bus Service	On-Airport Shuttle Service	Shuttles to Other Locations
Description of Service	• Regularly scheduled local and regional bus routes operated by public transit agencies. • Depending on demand, can be multiple-stop routes or, if demand warrants, express or semi-express routes to airport.	• Shuttle service transporting passengers and employees between parking lots and passenger terminal buildings. • Service typically provided when walking distances are greater than 600 to 1,000 feet. • Separate routes are often provided to segregate employees and traveling public.	• Terminal-to-terminal services for transporting both public and employees to fixed-rail transit services or off-airport terminal facilities. • Provide passengers with relatively high LOS (i.e., limited stops, curbside delivery of baggage and passengers).
Operating Characteristics	• Full-size buses with seating capacity of 35 to 55 passengers or articulated buses with seating capacity of 65 to 75 passengers. • Typically fixed route, scheduled service.	• Typically operated under business agreement by contractor for airport. • Types of vehicles (buses or vans) used vary due to passenger demand and physical characteristics of facilities. • Typical service — fixed route, multiple-stop, scheduled services; 10- to 15-minute headway during peak periods, service may be less frequent or on-demand basis during off-peak periods.	• Vehicle sizes vary depending on passenger demands (e.g., peak arrival and departure activity, employees shift times). Can be either full-size buses with capacity for 35 to 55 passengers or vans seating 16 to 20 passengers. • Typical headways less than 20 to 30 minutes. • Usually fixed-route, scheduled services.
Fare Characteristics	• Fares usually established by governing public transit agency. Higher rates may be established for express routes.	• Typically no charge to system users.	• Typically no charge or minimal charge to system users.
Market Applicability	Employees - high Resident passengers - medium Nonresident passengers - low	Employees - high Resident passengers - high Nonresident passengers - low	Employees - high Resident passengers - high Nonresident passengers - low
Ingredients for Success	• Express or semi-express service to major activity areas (e.g., central business ditricts (CBDs), popular tourist activity centers, residential areas with high concentrations of airport employees). • Travel time savings along access corridors. • Frequent service, especially during periods of peak airport passenger and employee demands.	• Frequent service, especially during periods of peak airport passenger and employee demand.	• Frequent service, especially during periods of peak airport passenger and employee demands. • Low fares, reduced travel time, reliability, convenience. • Coordination of efforts between the airport and other agencies (e.g., fixed-rail station or transit center).
Examples	• Suntran service at Tucson Int'l Airport • Service provided from Portland Int'l Airport to downtown Portland	• Shuttle service provided at Boston, Los Angeles, and Philadelphia Int'l airports to serve remote parking lots and multiple terminals	• Washington Flyer between Washington Dulles Int'l airport and a Metro station • Air Bart serving Oakland Int'l airport and a nearby commuter rail station • Van Nuys Express (L.A.) • Logan Express (Boston)

Depending on the location of the facilities to be served (e.g., employee and public parking lots, terminal buildings), the airport may provide separate shuttle routes to cover different geographic areas. Separate shuttle routes may also be provided to segregate employees and the traveling public. These services are often operated by a private company under a business agreement with the airport; this agreement typically describes the shuttle bus company's responsibilities in providing the service (e.g., service frequencies, vehicle requirements, driver training).

On-airport shuttle services are often provided on a fixed-route, multiple-stop, scheduled basis without charge to system users. The frequency and extent to which such services are provided vary, depending on the proximity of the parking facilities to the airport terminals or employment centers and demand for the service. Typically, service with fixed headway of less than 5 to 10 minutes is available during peak periods; service may be less frequent or on an on-demand basis during off-peak periods.

Shuttles to Other Locations

Shuttle services transporting both the traveling public and employees to fixed-rail transit services or off-airport facilities may be provided solely by the airport operator or in conjunction with local transit or fixed-rail service agencies. These services provide passengers with a relatively high LOS (e.g., limited stops, curbside delivery of baggage and passengers). Examples of shuttle service to fixed-rail stations include the Washington Flyer, serving Washington Dulles International Airport and a rail station located in West Falls Church, VA, and AirBart, serving Oakland International Airport and the Coliseum Bart station.

Privately Sponsored Services

Privately sponsored services include taxis and door-to-door shared-ride vans that provide passengers with service directly between the airport and their destinations. Privately sponsored services also include regularly scheduled fixed-route service between the airport and established stops. These services are described in table 6.4-3.

Taxis (Includes Medallion Taxis, Radio Taxis, or Metro Cars)

Taxis are exclusive-ride, door-to-door, on-demand services typically provided at large-, medium-, and small-hub airports. Taxis are frequently the second most commonly used mode of access to an airport. There are various types of operating arrangements between airports and taxi services. Some airports operate an "open access" system, allowing all properly permitted taxis (e.g., those with permits from appropriate governmental agencies, such as the local city or State Public Utilities Commission) to operate at the airport. Other airports enter into business agreement with a single taxi operator or group of operators who, in exchange for the exclusive right to pickup airport passengers, assume responsibility for operation of the service (e.g., driver training, vehicle and insurance requirements).

Table 6.4-3. Privately Sponsored On-Demand Services

Type of Service	Taxis	Door-to-Door Shared Ride Vans	Fixed-Route, Scheduled Services
Description of Service	Exclusive ride, door-to-door service typically provided at small-, medium-, and large-hub airports.	Demand-responsive services offered by private companies. May focus on providing services to specific geographic areas (i.e, northern suburbs, southern suburbs of a major metropolitan area).	Scheduled, line-haul services typically operated by private companies between airports and established stops (e.g., major activity and employment centers, areas with high concentrations of hotels and motels, intermodal transportation facilities).
Operating Characteristics	Sedans, vans, or station wagons used as service vehicles, typically holding five or fewer passengers.	Service typically provided in vans with seating capacity for 8 to 12 passengers. Sedans, station wagons, mini-buses, and stretch limousines may also be used.	Depending on demand, services may be provided in conventional transit buses with seating capacity of 35 to 55 passengers or in vans with seating for 16 to 20 passengers.
Fare Characteristics	Fares usually time-, zone-, or distance-dependent, usually for the entire vehicle, as recorded by taxi meter. Sometimes cab patron and driver may negotiate fare or agree to a fare based on authorized charges.	Typically flat fares or distance-based fares regardless of number of passengers transported.	Typically flat fares or distance-based fares.
Market Applicability	Employees - low Originating residents - medium Originating visitors - high	Employees - low Originating residents - high Originating visitors - medium	Employees - low Originating residents - medium Originating visitors - high
Ingredients for Success	• Quality of service • Availability of vehicles (waiting times) • Airport rules and regulations	• Quality of service • Number of stops en route • Cost (vs. taxi) • Travel time reliability	• Low fares (vs. other modes) • Travel time • Identification of efficient and effective routes to and from the airport to serve specific market and high activity centers.
Examples	• Local service	• SuperShuttle -- San Francisco airports -- Los Angeles airports -- Phoenix -- Dallas/Ft. Worth	• Marin Airporter • Connecticut

All the airports hold taxis in some type of staging facility. Most often the facility is within a few miles of the airport, if not directly on the terminal grounds. These staging facilities tend to be large enough to hold a considerable supply of taxis. For example, O'Hare International Airport has a facility large enough to hold 600 to 700 taxis. If the staging lot is full, the taxis wait at curbside, where there is room for about 20 taxis. San Francisco recently opened two overflow lots to handle extra taxis on the facility, which previously circulated through the roadway network until space in the staging lot was available. Washington National Airport has one staging facility that accommodates 485 taxis and another that accommodates over 100.

Typically, a curb starter or a dispatcher communicates by radio with the staging facility dispatchers to request taxis when they are needed. The staging facility dispatchers write a ticket, collect the exit fee, and stamp the ticket showing that the fee has been paid by the taxi. The taxi drives to the destination terminal, hands the ticket to the starter, picks up the passenger, and leaves the airport to dropoff the passenger. Usually, this is a first-in, first-out system, where the first taxi in line is the first to be called for duty. In several instances, when a taxi serves a short-haul trip and returns to the airport within a half-hour, it does not have to wait in line and no trip fee is charged. This provides some incentive for taxis to serve less profitable short-haul trips.

AVI technology for taxi monitoring was not used at any of the airports at the time of the survey; however, several airports were exploring use of AVI technology. San Francisco found that using AVI for taxis was too expensive, yet the airport uses AVI for tracking other ground transportation, such as shuttle buses and limousines. O'Hare was awaiting State approval for incorporating AVI technology into the ground transportation management system. Miami uses AVI to monitor the number of courtesy shuttles that continuously circle the roadway, but does not use AVI for taxi monitoring.

Door-to-Door, Shared-Ride Vans

These demand-responsive shared-ride services, offered by private companies, are often attractive to travelers who might otherwise drive alone to the airport and use on- or off-airport public parking facilities or rental car services. In metropolitan regions, door-to-door companies may focus on providing service to specific geographic areas (e.g., at Chicago O'Hare International Airport, Tri-State Coaches serves the south suburbs and Northwest Indiana and Airport Express serves the South Shore suburbs).

An individual wishing to use these services to go to an airport must call in advance to make reservations to be picked up at a specified place and time that will allow the passenger to get to the airport with sufficient time before the departure of his or her flight. At the same time, a passenger landing at the airport can either reserve a space in advance or make arrangements at the airport after landing to get from the airport to his or her destination. Typically, the van used for this service has a 7- to 11-person capacity and, for each trip, serves more than one traveling party or parties with more than one passenger. For the inbound trip to the airport, the driver will make trips to several pickup locations before heading to the airport for passenger dropoff. A passenger pickup point may be anywhere within the van's service area, such as a residence, business, or

Many airports have problems efficiently and effectively providing taxis for passengers terminating their trips at the airport. Taxis are sometimes not available during peak periods or inclement weather, while at off-peak times, a surplus of taxis may exist. Taxis may not be well maintained, drivers may not speak English very well, or passengers may be overcharged. In 1995, special taxi service agreements existed at a number of airports. Minneapolis-St. Paul International Airport allowed taxis permitted by four different agencies (i.e., Minneapolis, St. Paul, and two classifications of suburban counties) to operate at the airport. Seattle-Tacoma International Airport allowed taxi service by a consortium of drivers (i.e., owner-operators), formed at the request of the airport operator.

A survey was conducted in 1995 to determine how six large airports managed taxi operations.[22] Ground transportation managers, parking structure managers, and taxi managers at New York LaGuardia, Chicago O'Hare, Cincinnati, Miami, Phoenix, and San Francisco airports were interviewed. None of the airports had a formal taxi management plan. All airports placed some restrictions on which taxis were allowed to enter the airport to pickup passengers. LaGuardia and O'Hare require all empty taxis that enter the airport to have medallions showing that they are licensed by the city within which the airport is situated. Both airports restrict entry to only city-licensed medallion holders. Other taxis, not licensed in the city, may only dropoff passengers and may not enter the airport without passengers in the vehicle.

The taxi system at Cincinnati is run by an association of 13 taxi companies from two States (Kentucky and Ohio) that manage and police themselves. The association has an agreement with the airport in which the airport permits only taxis from the association to enter the airport to pickup passengers. Prearranged service is not allowed, and no other taxis are permitted to enter the airport.

Miami International permits all taxis licensed within Miami County to enter the airport, and San Francisco requires a city permit to enter the airport. Both airports allow unlicensed taxis to dropoff passengers, but they may not enter the airport specifically to pickup passengers. Phoenix contracts for taxi service with three companies, and only taxis from those companies may enter the airport to pickup passengers. Non contract taxis may only dropoff passengers and must then immediately leave the airport premises.

None of the surveyed airports charges a fee when taxis enter the airport, but all six charge when taxis exit the staging facility. Cincinnati Airport charges an exit fee of $2.00 per taxi. A $1.50 of the fee goes to the taxi association for management and administration costs of the taxi system. The money is used to pay the dispatchers and to manage the staging facilities and the taxi stands at curbside. The other $0.50 goes to the airport. Miami charges a $1.00 exit fee that is added to the fare on the taxi meter. Phoenix charges two types of fees. The first is a flat fee of $200 per vehicle per year. Each of the three companies with service contracts is responsible for paying the fee for each of the vehicles working at the airport. This flat fee helps with the administrative costs incurred by the airport for quarterly vehicle inspection, decals, meter inspection, and insurance. Phoenix also charges a $1.00 trip fee, paid by the driver on leaving the staging lot, which is added to the passenger's fare.

hotel. For the outbound trip from the airport, the process works in reverse. The van picks up passengers curbside at the airport terminal, delivers them to their destinations, and after dropping off the last passenger, repeats the cycle by picking up passengers heading to the airport.

For the service to be cost effective, it is better to serve a densely populated area that provides enough airline passengers to use the service. Providing service to areas with low airport trip generation is less profitable, because the pool of potential passengers is smaller. At airports in less densely populated areas, it may be necessary to combine trips from more dispersed locations, which may increase the travel time, especially for those passengers picked up first on the route heading to the airport or dropped off last when leaving it. Routes should be planned to minimize delay, so passengers may complete their trips with minimal waiting times and detours to pickup and dropoff other passengers.

Factors likely to favor the use of door-to-door van airport service are:[23]

- Relatively short time for travel to and from the airport (because it does not involve a transfer, as does public transit or fixed-route services)
- Limited mobility of one or more persons in the travel party (small children, elderly, handicapped)
- Heavy baggage or many pieces of baggage
- Adverse weather conditions.

Door-to-door van operators typically charge a fare for each person who rides; for multiple-person parties, the operators may offer a reduced fare for each additional person after the first. Typically, rates vary by location and distance, but other factors, such as tolls or whether a passenger purchases a round-trip or one-way ticket, may affect the fare.

Factors that encourage a passenger to choose door-to-door van airport service over another transportation mode to the airport include:

- Private automobile not available for trip
- Trip duration of several days, resulting in high airport parking fees
- Travel costs or taxi use not reimbursable (nonbusiness travelers)
- Unfamiliarity with the geography of the region or with alterative public transportation options (visitors)
- Familiarity with door-to-door van airport service from experience, referral, or available literature.

Fixed-Route, Scheduled Services

These scheduled line-haul services are typically operated by private companies between the airport and established stops (e.g., major activity and employment centers, areas with a high concentration of hotels and motels, and intermodal transportation facilities). Examples of this type of service include the Raz Trans Airporter at Portland International

Airport serving selected hotels, the convention center, and the Greyhound bus station, and the Connecticut Limousine, serving the three New York City airports and selected areas in New York and Connecticut. These services may be provided by private operators under exclusive concession agreements with the airport or on a competitive basis.

Prearranged Services

Prearranged transit services typically involve passengers calling in advance for vehicle services. These services, described in table 6.4-4, include chauffeured limousines, charter vans and buses, and courtesy vehicles.

Chauffeured Limousine Services

At some airports, chauffeured limousine service is available on-demand, possibly illegally or improperly. These services are usually expensive and provide high-quality individualized service to passengers.

Charter Vans and Buses

These charter services are usually provided by operators of tour companies for special, infrequent group events that require the use of a full-size bus (i.e., seating capacity of 35 to 55 passengers) or for regularly scheduled events, including the transportation of cruise ship passengers. Because of space constraints at the terminal curbside and because it is often necessary for operators of these vehicles to wait while passengers claim baggage, separate staging facilities (e.g., courtyards) may be provided.

Courtesy Vehicles

Courtesy vehicles are typically shared-ride, on-demand services provided for customers of on- and off-airport rental car agencies, hotels, motels, off-airport public parking lots, and other companies.

At many airports, courtesy vehicles provide service at regular intervals (e.g., headway of less than 10 to 15 minutes) regardless of the demand. During off-peak periods or at locations where demand for these services is low or sporadic, passengers may be required to notify the agency of their arrival at the airport to arrange for transportation services.

Table 6.4-4. Privately Sponsored Prearranged Services

Type of Service	Chauffeured Limousines	Charter Vans/Buses	Courtesy Vehicles
Description of Service	Exclusive-ride services provided on prearranged basis with passengers calling in advance for vehicle services.	Usually provided by operators of tour companies or for special, infrequent group events that require use of full-size bus (35 to 55 passengers) or for regularly scheduled events (e.g., cruise ship passenger activity).	Typically shared-ride, on-demand services provided for customers of on- and off-airport rental car agencies, hotels, motels, and off-airport public parking lots.
Operating Characteristics	Private companies offering services usually provide stretch or luxury limousines with maximum seating capacity of four to five passengers.	• Depending on demand, services may be provided in full-size buses or mini-buses with seating for 16 to 20 passengers. • Because of space constraints at curbside and because operators may wait while passengers claim baggage, separate staging facilities may be provided .	• Operators of the primary services (e.g., hotels, parking facilities) may provide a variety of vehicles to transport patrons to and from the airport, including vans, mini-buses, and full-size buses. • Service may be provided at regular intervals (e.g., headways less than 10 to 15 minutes) regardless of demand. • At locations with low, sporadic demand, passengers may be required to notify respective agencies of their arrival at the airport to arrange for services.
Fare Characteristics	Fares typically charged on per hour or daily basis regardless of number of passengers being transported.	Charter companies usually paid per hour regardless of number of passengers being transported.	Typically no charge to system users, because transportation is considered part of, or incidental to, primary services being provided.
Market Applicability	Employees - none Originating residents - medium Originating visitors - medium	Employees - low Originating residents - low Originating visitors - high	Employees - low Originating residents - low Originating visitors - high
Ingredients for Success	• High proportion of business trips • Fare (compared to parking costs) • Provision of high levels of passenger service	• Not airport-dependent	• Frequency of service • Quality of service
Examples	Local service	Local service	Most hotels, motels, rental car agencies, and private parking lots

Airport Rail Services

Many airports face severe congestion problems caused by rubber-tired access to the airport. Rail transit is often considered an alternative for solving these congestion problems; however, rail service is not a viable option for most airports, and even the most successful airport access rail service in the United States carries less than 10 percent of originating and terminating passengers to and from the airport. The most successful European service does not achieve more than a 30 percent mode split. However, in locations where desirable characteristics, such as those described in this section occur, rail does offer some benefits. The literature indicates that the perceived primary benefits of rail service are the following:[24]

- Provides an environmentally friendly and cost-effective airport access mode that can attract passengers who would otherwise travel in automobiles
- Reduces congestion on access routes and airport roadways
- Enhances a community's image as a modern, world-class city and can assist in attracting business, tourism, and new airline service to a community.

Desirable Characteristics of Rail Service

The technical characteristics of both existing urban rail and light-rail technologies and proposed advanced transit systems and magnetically levitated or linear induction rail systems have been described in numerous publications.[24] Airport rail systems that attract the highest percentage of airport passengers and employees appear to have the following common characteristics:

- *Direct Service* — Rail services that allow passengers to travel between the airport and major activity centers (e.g., the central business district (CBD), tourist attractions) without making transfers or incurring numerous stops
- *Frequent Service* — Rail services that minimize passenger waiting times by providing headway of 10 minutes or less during peak periods, thereby reducing travel times and enhancing the convenience of the system
- *Extensive Regional Coverage* — Airport rail systems that are part of a comprehensive network of rail service and feeder buses provide an attractive alternative to a greater number of potential passengers than systems that consist of a single line (e.g., between the airport and the CBD)
- *Available Parking* — Residents who wish to park at rail stations away from the airport and use rail as their airport access mode will be influenced by the availability of parking at nonairport stations. The operators of some commuter rail systems prohibit overnight parking to increase parking availability for typical nonairport commuters.

- *Through Service* — Routes that continue past the airport will likely support more frequent service and attract more ridership than routes that terminate at the airport.

In a very few European airports, rail service is provided using dedicated trains with special features, such as unique exterior color schemes, onboard attendants, and oversize baggage compartments or provision for hanging garments. However, to allow equipment to be interchanged throughout the system, most rail operators prefer to use standard equipment on the airport lines.

Desirable Characteristics of Airport Rail Stations

Airport rail stations that have attracted the highest percentage of airport passengers and employees appear to have the following common characteristics:

- The station is located within convenient walking distance of the terminal. Ideally, the rail station is:

  - Located within 500 feet of the terminal building, thereby avoiding the need for passengers to ride a shuttle bus or transfer to a people-mover system to go to the terminal building

  - Designed to minimize (or avoid) the need for passengers to change levels, climb stairs, or use an escalator. Grade-separated paths between the terminal building and rail station should, however, be provided to eliminate the need for passengers to cross roadways. Grade-separated paths enhance passenger safety and eliminate impact on roadway operations

  - Designed to accommodate passengers with baggage carts or suitcases with wheels

  - Designed to comply with ADA requirements

  - Located adjacent to the baggage claim areas, where passengers select from the available travel modes.

- Baggage handling is made easier. Ideally, passengers are offered:

  - Porter service to assist in transporting baggage between the terminal and rail platform (or rail car)

  - Baggage trolleys that can accompany a passenger on the entire route between the baggage claim area and the rail platform, including on escalators

  - Baggage handling services that allow passengers to check their baggage to (or from) their ultimate destinations. For example, the Swiss "Fly/Rail-Baggage" service allows passengers to check their bags at any of over 100 rail stations in Switzerland through to their final destinations (avoiding the need to claim and recheck bags at the airport). Passengers may also choose to check their bags at any Swiss Air airport ticket counter in any nation (or at certain other airline ticket counters) through to any of 100 Swiss rail stations. Examples of more limited baggage-handling services exist in Sweden and Japan.

- The station provides good information systems. Good information systems include:

- Clear signs and graphics, posted in highly visible locations at frequent intervals throughout the terminal and rail station to facilitate passenger wayfinding

- Information describing fares, schedules, and best routes to popular destinations. This information should be presented simply and clearly (i.e., to be easily understood by persons who are unfamiliar with the rail system and the region)

- Pathways that allow passengers to identify their destinations and minimize their reliance on signs

- Airline flight information displays in the rail station to assist rail passengers in finding the proper terminal building or concourse

- Staffed information booths to supplement available signs and computerized terminals.

- The station is designed to enhance passenger comfort and convenience. Examples of desirable design features include:

  - Passenger amenities, such as telephones, benches, vending machines, and concession areas

  - Passive and active security features (e.g., video or audio monitoring of platforms and station areas, well-lit corridors, visible elevators, roving security personnel)

  - Sheltered waiting areas with heating and air conditioning.

Access Characteristics of U.S. Airports

<u>Access to Airports Served by Rubber-Tired Transit</u>

High-occupancy access to most U.S. airports is provided only by rubber-tired transit. This section describes the characteristics of service at selected U.S. airports. Data on mode of access used were assembled from the most recent passenger surveys at 36 U.S. airports. Airports were then categorized into those served by rail transit and those only served by rubber-tired vehicles. Airport access modes (e.g., limousines) are defined differently in different airport access surveys. The seven airport access modes reported in the following sections were defined as follows:[25]

- *Private Auto* - passenger-driven auto, passenger dropoffs, parking lot shuttle
- *Rental Car* - rental car, rental car courtesy vehicle
- *Taxi* - city taxi, suburban taxi
- *Other On-Demand Services* - limousine, door-to-door van, charter bus, military bus
- *Scheduled Bus and Van Services* - city transit bus, regional bus, airport express/shuttle services
- *Courtesy Vans* - hotel and motel courtesy vans

- *Rail* - rail and light rail transit, regional and commuter rail services, AMTRAK; also includes feeder service to local rail

- *Other* - helicopter, water shuttle/ferry, walking.

Data for airports served by only rubber-tired vehicles are presented in this section and data for airports served by rail transit are provided in the next section. Airports served by rubber-tired transit were categorized by size, based on the number of annual originations (originating and terminating passengers) served by the airport.

Airports With Fewer Than 500,000 Originations/Year

Data were available for only five airports with fewer than 500,000 annual originations. These airports are identified in table 6.4-5, along with annual originations, the percent of total enplanements that were originations, and the year that the survey was conducted. Table 6.4-6 shows mode of access information for airports with fewer than 500,000 annual originating passengers. Each of the four airports in this category primarily serves originating passengers (over 80 percent of enplanements). Travel time to the airport from the CBD can range from 5 minutes at Palm Springs by taxi to as long as an hour by bus at Long Beach. Transit use for these airports ranges from 2.3 percent in Long Beach to 15.2 percent in Savannah.

Table 6.4-5. Airports With Fewer Than 500,000 Originations

Airport	Originations (Millions/Yr)	Percent Originations	Survey Year
Palm Springs (PSP)	.2	90	1990[25]
Springfield Reg. (SPI)	.2	85	1993[26]
Long Beach (LGB)	.3	96	1991[25]
Savannah (SAV)	.4	80	1989[25]
Atlantic City Intl. (ACY)	.1*	100	1995[27]

* Does not include charter flights

Airports With 500,000 to 2.5 Million Originations/Year

Data for only five airports were available for this group. These airports are identified in table 6.4-7, along with originations, the percent of total enplanements that were originations, and the year that the survey was conducted. Mode of access data for these airports is provided in table 6.4-8. These airports shared many characteristics with the airports in the previous category. Originating passengers at three of the airports use private vehicles less than 60 percent of the time and heavily use rental cars, taxis, and transit. Transit is used for access at these three airports over 12 percent of the time. This can be attributed to the high number of nonresident, nonbusiness trips made to those airports.

Table 6.4-6. Mode of Access to Airports With Fewer Than 500,000 Annual Originating Passengers

Airport	PSP*	SPI	LGB	SAV	ACY
Mode Split (%)					
Private vehicle	43.0	38.0	70.8	37.1	58.0
Rental car	38.0	46.0	16.6	43.5	2.0
Taxi	8.0	3.0	10.3	4.2	10.0
Other on-demand	--	4.0	--	8.0	24.0
Scheduled bus/van	--	--	1.5	2.3	4.0
Courtesy vans	8.0	2.0	--	--	--
Other	3.0	7.0	0.8	4.9	2.0
Travel Time to Airport (Minutes)[28]					
Via taxi	5	15	20-70	15	15
Via bus	15	--	45-60	15	--
Travel Cost to Airport[28]					
Via taxicab	$5	$8	$15-$35	$15	$27
Via bus	$0.50	--	$0.75-$2.70	$12	--
Bus Headway (Minutes)[28]	30	--	30	10	--

* Palm Beach serves many nonresidential, nonbusiness passengers

Table 6.4-7. Airports With 500,000 to 2.5 Million Originations

Airport	Originations (Millions/Yr)	Percent Originations	Survey Year
Wichita (ICT)	.5	83	1989[25]
Albany (ALB)	.8	94	1993[28]
Tucson (TUS)	1.1	85	1991[29]
Reno (RNO)	1.8	82	1989[25]
Indianapolis (IND)	2.3	85	1993[28]

Table 6.4-8. Mode of Access to Airports With 500,000 to 2.5 Million Annual Originating Passengers

Airport	ITC	ALB	TUS	RNO	IND
Mode Split (%)					
Private vehicle	76.5	58.0	50.8	48.3	70.6
Rental car	14.5	15.0	31.1	27.8	20.5
Taxi	3.9	9.0	4.4	7.9	1.3
Other on-demand	3.2	5.0	4.9	1.8	2.4
Scheduled bus/van	--	4.0	0.6	12.4	0.5
Courtesy vans	--	6.0	6.8	--	4.7
Other	1.9	3.0	1.4	1.8	
Travel Time to Airport (Minutes)[28]					
Via taxi	10-15	20	15-20	5-10	15
Via bus	--	20-30	25	20	--
Travel Cost to Airport[28]					
Via taxi	$7.60	$13.00	$15-417	$8.00	$16.00
Via bus	--	$0.75	$0.75	$1.00	$1.00
Bus Headway (Minutes)[28]	--	30-60	60	25	30-60

Airports With 2.5 to 5 Million Originations/Year

Data were available for 11 airports with 2.5 to 5 million annual originations. These airports are identified in table 6.4-9, along with originations, the percent of total enplanements that were originations, and the year the survey was conducted. The majority of enplanements at St. Louis, Minneapolis-St.Paul, and Houston Intercontinental airports are not originations. John F. Kennedy Airport also serves a high proportion of enplaning passengers that do not use ground transportation. These airports all serve as hubs for major air carriers or have a large number of international flights. The remaining airports serve a high proportion of originating flights (70 percent to 98 percent of enplanements). Chicago Midway and St. Louis Lambert are included in this group, because they did not have rail service at the time of the survey; however, they have since added rail service. Mode of access information for the 11 airports that serve 2.5 to 5 million annual originating passengers is provided in table 6.4-10.

It is difficult to characterize the key factors contributing to transit ridership to and from these 11 airports. The access to San Jose by private vehicle, rental car, and taxi is 94 percent, while only 6 percent of passengers use transit.

Table 6.4-9. Airports With 2.5 to 5 Million Annual Originations

Airport	Originations (Millions/Yr)	Percent Originations	Survey Year
Chicago Midway (MDW)	2.6	88	1990[25]
San Jose (SJC)	2.8	87	1990[25]
Ontario California (ONT)	3.0	98	1987[25]
New Orleans (MSY)	3.0	91	1994[30]
Portland (PDX)	3.0	70	1990[25]
Ft. Lauderdale (FLL)	3.4	87	1990[25]
Tampa (TPA)	4.0	83	1990[25]
Houston (IAH)	4.1	47	1986[31]
St. Louis (STL)	4.4	45	1990[32]
John F. Kennedy (JFK)	4.8	58	1993[33]
Minneapolis (MSP)	4.9	47	1985[25]

Conversely, 36 percent of the passengers at JFK use transit, while less than 38 percent use private vehicles. The high transit use at JFK can probably be attributed to its location in and the large proportion of originating passengers that are traveling for more than a few days on an international trip. New York City (the highest transit use city in the United States) and the large proportion of originating passengers that are traveling for more than a few days on an international trip. Transit use at other airports can be explained by a number of factors.

Portland has a popular scheduled bus and express service, and Tampa has popular courtesy and shuttle van services. Ft. Lauderdale has a large number of cruise ship bus passengers and, therefore, has a high use of scheduled bus and van service. New Orleans serves a high number of nonbusiness, nonresident passengers who heavily use taxis and other on-demand services for travel to and from the airport.

Airports in this group illustrate more than any of the other groups how the unique characteristics of each airport, particularly the markets served, determine how passengers get to and from the airport.

Airports With More Than 5 Million Originations/Year

Data were available for seven of these large airports, which are not served by rail transit. These airports are identified in table 6.4-11 along with originations, the percent of total enplanements that were originations, and the year that the survey was conducted. These larger airports, except for Miami and Seattle, primarily serve originating passengers. Miami and Seattle serve a large number of international flights. At La Guardia, which is the New York airport that primarily serves passengers traveling to and from the New York area, 84.9 percent of the enplanements are originating trips.

Table 6.4-10. Profile of Airport Characteristics for Airports With 2.5 to 5 Million Annual Originating Passengers

Airport	MDW	SJC	ONT	MSY	PDX	FLL	TPA	IAH	STL	JFK	MSP
Mode Split (%)											
Private vehicle	48.3	66.1	59.0	21.0	64.0	46.0	48.6	67.0	63.4	38	67.4
Rental car	10.6	24.7	22.2	18.0	18.0	27.5	32.4	15.0	12.5	3	12.2
Taxi	26.8	3.4	6.3	33.0	5.0	10.0	2.8	7.0	12.0	24	7.3
Other on-demand	9.7	2.1	3.2	24.0	--	5.7	11.0	--	1.0	21	6.9
Scheduled bus/van	0.6	1.2	3.6	1.0	6.0	8.5	0.6	5.0	1.7	10	1.9
Courtesy vans	1.5	2.2	3.4	3.0	7.0	2.0	3.7	3.0	6.1	3	4.3
Other	2.5	0.3	2.3	--	--	0.3	0.9	3.0	3.3	2	--
Travel Time to Airport (Minutes)[28]											
Via taxi	20-30	10-45	25-90	20-30	20	5-7	20-40	30-40	15-30	35-60	15-30
Via bus	20-50	15-20	30-120	50	25	5-7	30	60	10	20-75	42
Travel Cost to Airport [28]											
Via taxi	$17-$20	$16-$35	$25-$90	$21	$22	$8	$13-$15	$30-$40	$13-$18	$30-$35	$20
Via bus	$1.80	$1	$0.75-$3.85	$1.10	$1	$8-10	$0.85	$1.20	$1.35	$1.25	$0.90
Bus Headway (Minutes)[28]	12-14	30-60	60	10-20	15-30	20	60	20-25	7-15	30	20-40
Key Factors Contributing to Transit Ridership	--	Dispersion of origins/ destinations; many business and resident passengers	--	Many nonresident, nonbusiness passengers	Scheduled bus and express service	Large volume of cruise ship bus passen-gers	Primarily courtesy and shuttle van service	Distance from CBD; unit terminals	--	Unit terminals ; local service to CBD	--

Table 6.4-11. Airports with More than 5 Million Originations/Year

Airport	Originations (Millions/Yr)	Percent Originations	Survey Year
Seattle (SEA)	6.0	67	1988[34]
Miami (MIA)	6.1	60	1991[35]
Orlando (MCO)	6.4	74	1990[25]
LaGuardia (LGA)	7.9	85	1993[33]
Newark (EWR)	8.4	76	1993[33]
San Francisco (SFO)	9.9	71	1993[36]
Los Angeles (LAX)	13.6	74	1993[37]

Mode of access data for these airports are provided in table 6.4-12. Of the seven airports in this category, five have passengers that use on-demand services, such as limousine, door-to-door vans, and hotel/motel courtesy vehicles, more than all other transit alternatives. La Guardia and Newark have a high demand for on-demand limousine service. San Francisco and Los Angeles have successful on-demand, shared-ride van services. Orlando passengers use scheduled bus and van services more than any other transit alternative. This may be because Orlando is a tourist destination with many tour packages. These tour packages provide bus service to and from the airport for the many nonresident tourist passengers who frequent the airport.

<u>Airports With Rail Service</u>

Data were available for nine airports with rail service. Cleveland Hopkins, Philadelphia, Washington National, Atlanta Hartsfield, and Chicago O'Hare airports have rail transit stations within walking distance of the terminals. Four others, Washington Dulles, Boston Logan, Baltimore- Washington, and Oakland, have shuttle bus service to a rail station. These airports are identified in table 6.4-13. All the airports in this group serve more than 2.5 million originating passengers, and all but Hartsfield and O'Hare (major transfer hubs) primarily serve originating passengers. Hartsfield and O'Hare are the two largest transfer points in North America; although only 40 percent of enplanements at those airports are originations, they both serve over 8 million annual originations.

In North America, rail systems have been most successful at airports serving frequent travelers who have little or no baggage (e.g., passengers on shuttle flights) and in locations where rail offers faster or more reliable travel times because of congestion on access routes or lack of parking at the airport.

Table 6.4-14 shows mode of access information for the five airports that have rail stations within walking distance of the terminals. Access by rail to these airports ranges from 2 percent of originating passengers at Philadelphia International to over 9 percent at Washington National and Atlanta Hartsfield. Philadelphia International has the highest overall transit use (over 28 percent).

Table 6.4-12. Mode of Access for Airports With More Than 5 Million Originating Passengers/Year

Airport	SEA	MIA	MCO	LGA	EWR	SFO	LAX
Mode Split (%)							
Private vehicle	78.8	44.5	33.2	30.0	52.0	43.0	50.9
Rental car	5.2	25.5	46.2	4.0	10.0	18.0	19.6
Taxi	2.6	12.2	5.4	36.0	7.0	8.0	5.4
Other on-demand	--	12.9	1.0	21.3	20.8	16.0	9.4
Scheduled bus/van	8.0	1.2	8.1	5.0	5.9	8.0	6.0
Courtesy vans	3.7	3.7	1.9	1.0	3.0	6.0	4.9
Other	1.7	--	4.2	1.0	1.0	1.0	3.8
Travel Time to Airport (Minutes)[28]							
Via taxi	20-45	20	25	20-40	30-45	25	30-45
Via bus	40	35-40	40	20-75	30-45	30-50	45-50
Travel Cost to Airport[28]							
Via taxi	$12-$48	$16.50	$24	$15-$25	$30-$35	$29	$27-$30
Via bus	$1.60	$1	$0.75	$1.25	$7	$1.75	$1.10
Bus Headway (Minutes)[28]	30	60	60	10-20	15-30	30	30
Key Factors Contributing to Transit Ridership	--	--	Destination resort; many nonresident/ nonbusiness passengers	Taxi and on-demand (black car services attractive)	Characteristics of New Jersey market; on-demand limousines; high cost of parking	Concentration of origins/ destinations; on-demand, shared-ride vans successful	On-demand, shared ride vans successful; dispersion of origins/ destinations

Table 6.4-13. Airports With Rail Service

Airport	Originations (Millions/Yr)	Percent Originations	Survey Year
Cleveland Hopkins (CLE)	2.9	74	1988[25]
Philadelphia (PHL)	5.0	69	1993[25]
Washington National (DCA)	6.4	89	1992[38]
Atlanta Hartsfield (ATL)	8.4	38	1989 [39]
Chicago O'Hare (ORD)	12.8	44	1989[25]
Washington Dulles (IAD)	2.7	68	1992[38]
Boston Logan (BOS)	8.2	80	1993[40]
Baltimore Washington (BWI)	3.0	75	1992[38]
Oakland (OAK)	3.1	88	1990[25]

Table 6.4-15 provides mode of access information for the airports that have shuttle buses to a rail station. Rail is used for access at two of these airports (Washington Dulles and Oakland) less than 1 percent of the time. At Baltimore-Washington International, rail is used 1 percent of the time, and at Boston Logan, which is the airport in this group with the best rail service, rail is used by almost 6 percent of originating passengers. Shuttle bus service to a rail station does not appear to attract many airport users, unless it is very convenient and serves a congested airport, such as Logan.

A characteristic common to all the successful rail facilities is that, for the most part, they provide a travel time savings and a travel cost savings. Travel to the airports by rail takes between 10 to 20 minutes less time than travel by taxi or bus, with the exception of Philadelphia International.

Parking availability tends to be a problem at many airports served by rail. This may cause travelers to use alternatives to private vehicles if they cannot be guaranteed parking at the airport. Ample parking exists at the rail stations and at Atlanta, Philadelphia and Cleveland Hopkins airports. Washington National and Boston have constrained access, limited parking, and site congestion.

Table 6.4-14. Mode of Access for Airports With Rail Within Walking Distance

Airport	CLE	PHL	DCA	ATL	ORD
Mode Split (%)					
Private vehicle	73.4	49.0	33.0	60.0	47.0
Rental car	11.2	18.0	11.0	15.0	9.9
Taxi	5.0	5.0	36.0	7.0	14.8
Other on-demand	--	13.0	3.0	--	15.1
Scheduled bus/van	3.0	5.0	--	--	4.6
Courtesy vans	3.0	3.0	6.0	--	4.5
Rail	2.8	2.0	9.0	9.3	3.8
Other	1.6	5.0	2.0	8.7	0.3
Travel Time to Airport (Minutes)					
Via rail	22-25	25-30	35-40	16	35-40
Via taxi	15-30	15-30	10-20	15-20	25-60
Via bus	30-45	15-30	10-20	35-40	45-60
Travel Cost to Airport[28]					
Via rail	$1.50	$7.50	$1.25	$1.25	$1.50
Via taxi	$16-$17	$22-$25	$9-$16	$15	$25-$30
Via bus	$10-$15	--	$8	$8	$15
Bus Headway (Minutes)[28]	15	--	30-60	15-60	5-10
Rail Headway (Minutes)[28]	12	30	5-10	8-15	5
Rail Station Location	Under terminal	Four stops, each bag claim area	Across road	Near baggage claim area	Under garage
Rail Station Distance to Terminal (ft)	330	330	1,650	330	1,000
Key Factors Contributing to Transit Ridership	- Little time savings - Parking available - No access congestion - Low visibility	- High cost - Transfer required to CBD - Parking available	- Frequent users, shuttle passengers - Access congestion - Lack of parking - Convenient	- Travel time savings - Convenient CBD service - Parking at stations - Parking available	- Reliable travel time - Travel time savings - Travel cost savings - Used by employees

Table 6.4-15. Mode of Access for Airports With Shuttle Bus to Rail

Airport	IAD	BOS	BWI	OAK
Mode Split (%)				
Private vehicle	58.0	40.1	63.0	69.0
Rental car	18.0	14.0	17.0	16.9
Taxi	14.0	18.2	7.0	3.0
Other on-demand	--	12.8	--	2.3
Scheduled bus/van	5.0	4.2	7.0	6.6
Courtesy vans	5.0	1.9	4.0	1.5
Rail	--	5.8	1.0	--
Other	--	3.0	1.0	0.7
Travel Time to Airport (Minutes)[28]				
Via rail	37-42	20	--	--
Via taxi	45-60	15-30	16-18	10-45
Via bus	45	30-60	25-35	30
Travel Cost to Airport[28]				
Via rail	$9.65	$0.85	--	--
Via taxi	$35-$40	$12-$20	$15-$25	$20-$30
Via bus	$16	$5-$8	$1.75	$1
Bus Headway (Minutes)[28]	30	30-60	40	30-60
Rail Headway (minutes)[28]	--	8-12	--	--
Rail Station Location	None	Remote	None	--
Rail Station Distance to Terminal	Miles	5,250 feet (Shuttle bus)	Miles	Miles
Key Factors Contributing to Transit Ridership	- Bus to rail - Distance from CBD	- Reliable travel time - Constrained access - Shuttle passengers - Large rail service area - Service to CBD	- Bus to rail - Distance from CBD	- Frequent users, shuttle passengers - Bus to rail

6.5 Intermodal Transportation Facilities

Intermodal transportation facilities are designed to accommodate various modes of transportation and to allow for the transfer of passengers and/or cargo from one travel mode to another. Traditionally, intermodal transportation facilities have been planned to facilitate cargo transfer (e.g., from air or shipping modes to rail or trucking modes and vice versa). However, with growing concerns over air quality levels, the move toward encouraging the use of HOVs as a means of relieving congestion, and governmental legislative impetus (e.g., passage of 1991 ISTEA and the Clean Air Act Amendments) there is increasing interest in providing facilities for intermodal transfer of passengers, as well as cargo.

In the airport environment, intermodal passenger transportation facilities should provide convenient and efficient transfers from one travel mode to another to facilitate trips to and from the airport. According to the Center for Transportation Studies:

> the design of an intermodal facility is dictated by the nature of the transfers occurring there. Fundamentally, the transfer is perceived as an impediment to travel. All trips involving more than one mode of travel require a transfer, as do many trips on a single mode. Experience has shown that where the difficulty of transferring has been reduced, user satisfaction and the amount of travel have both increased. Since transfers cannot be entirely eliminated, it is essential to make them as quick and pleasant as possible.[41]

The special requirements of airport travelers, visitors, and employees should be accommodated. This should include minimizing walking distances between any two travel modes, providing timed transfers and connections to minimize delays, and limiting baggage-carrying. Efforts to achieve high levels of passenger service are necessary to encourage the use of HOVs such as rail, transit, and commercial vehicles, usually available at such facilities. In addition to these more popular modes of travel, many others could be used to and from an intermodal transfer facility.

> **Four "C's" have been identified as the core of intermodal transportation facility planning:**
>
> (1) **Connections:** The convenient, rapid, efficient, and safe transfers of people and goods among modes that characterize comprehensive and economic transportation service, (2) **Choices:** Opportunities afforded by modal systems that allow transportation users to select their preferred means of conveyance, (3) **Coordination:** and (4) **Cooperation**: Collaborative efforts of planners, users, and transportation providers to resolve travel demands by investing in dependable, high-quality transportation service, either by a single mode or by two or more modes in combination.[42]

Various types of on-airport and off-airport intermodal transportation facilities can be provided for the benefit of airport passengers, visitors, and employees. *Evaluation of Intermodal Transportation Facilities*, prepared for the FHWA, may be used as a guide for evaluatimg an intermodal transportation facility.[41] Types of intermodal facilities and their specific planning and design considerations are described in the following sections.

On-Airport Intermodal Facilities

Table 6.5-1 provides specific planning and design considerations for on-airport intermodal facilities. On-airport intermodal facilities are typically designed to improve circulation at the terminal curbside by separating some or all commercial transportation activity (e.g., shuttle services, courtesy vehicles, prearranged ground transportation) from private vehicle activity. Such separation of activity minimizes curbside requirements at the terminals. In addition, these facilities provide improved LOS for passengers using some modes of shared-ride transportation to the airport, because fewer interterminal and on-airport stops are required. The intermodal facilities can vary in the level of passenger amenities, services, and functions available and can be classified broadly as "mini-terminals," "mega-terminals," or "intermodal terminal facilities."

Modes of Access To An Intermodal Transfer Facility[41]

- Automobile: Kiss-n-Ride, Park-n-Ride, Private, Package Dropoff, Rental
- Metrorail
- Light Rail Transit (LRT)
- Personal Rapid Transit (PRT)
- Group Rapid Transit (People-Mover)
- Buses: Local, Express, Intercity, Tours, School
- Shuttles, Trams
- Limos
- Taxis
- Bicycles
- Motorcycles
- Commuter Rail
- Intercity Rail: High Speed, Conventional
- Handicapped Services
- Delivery: Packages, Mail, Freight, Baggage
- Boats: Ferries, Water Taxis, Private Boats

<u>Mini-Terminals</u>

This classification refers to such facilities as bus shelters or waiting rooms located near a parking structure, the baggage claim area, or adjacent to a commercial vehicle lane. Mini-terminals do not have many passenger amenities and often are just a small waiting room or a covered shelter.

<u>Mega-Terminals/Ground Transportation Centers (GTCs)</u>

Most often referred to as ground transportation centers, these facilities are typically multistoried buildings with passenger pickup and dropoff for various modes (car, taxi, courtesy bus, shuttle). Many times these facilities also have ticketing, rental car facilities, baggage claim, and automated people-mover systems to link centers with passenger terminals. This provides

Table 6.5-1. On-Airport Intermodal Transportation Facilities

Type Of Facility	Description	Examples	Planning Issues To Be Considered
Mini-Terminals	Bus shelters, waiting rooms with limited passenger amenities, covered shelters. Located near parking structure or lot, perhaps adjacent to commercial vehicle lane, near baggage claim area.	Portland International Airport provides covered shelters for passengers waiting at island curbside adjacent to roadway.	Consider airport policies and studies related to land-use planning, terminal area planning, and surface access planning (new roadways, links to existing or planned rail systems). Identify potential constraints at sites and access constraints, such as freeway construction. Identify type of facilities to be provided at intermodal facility vs. airport facility. Design facility to allow for flexibility to expand or reassign areas based on changing needs.
Mega-Terminals/ Ground Transportation Centers (GTC)	Multistoried buildings with passenger pickup and dropoff for various modes, ticketing, baggage claim, rental car facilities, etc.	San Francisco, Los Angeles, and Miami International airports are currently planning for specially designated GTCs at sites separate from terminal.	Design facility to minimize walking distances; separate pedestrian and vehicular activity; minimize need for passenger signs, etc. Provide reliable and rapid transportation service between facility and airport. Coordinate timed transfers and connections of various modes to minimize passenger delays.
Intermodal Terminal Facility	Airports that, within their terminal facilities, serve as convenient transfer points for various modes of travel. Typically, integration of air, bus, and commuter rail operations within one transportation center.	Michigan Regional Airport has provision for air, bus, and commuter rail operations within the Michigan Transportation Center.	Consider mode-specific planning and design related to operational and enforcement issues. Consider potential passenger perceptions of level of convenience resulting from number of mode transfers and location of facility in relation to boarding areas. Consider availability of funding sources for financing facility, including both airport and nonairport sources.

a transfer convenient for both passengers and employees of the airport. GTCs are often at a location separate from the passenger terminal.

Intermodal Terminal Facility

This classification refers to airports that, within their terminal facilities, serve as convenient transfer points for various modes of travel. In other words, an area within the airport itself serves as an intermodal transfer facility offering connections to bus and commuter rail operations, integrating all three services under one roof.

Planning Issues To Be Considered in Designing On-Airport Intermodal Facilities

- Consider airport policies and studies related to land use planning, terminal area planning, and surface access planning (e.g., new roadways, links to existing or planned rail systems).
- Identify potential constraints at the sites, including available area, environmental concerns, signalized intersections near or at capacity, inadequate queuing capacity to enter and exit the proposed facility.
- Identify the type of facilities that should be provided at the intermodal facility versus those that should be located at the airport terminal (e.g., commercial vehicle curbsides, rental car facilities, concessions, offices, passenger ticketing, baggage check in, public or employee parking, vehicle staging area).
- Design the facility to allow for flexibility to expand or to reassign areas as ground transportation and passenger needs change.
- Design the facility to ease passengers' walking distance, confusion about signs, or baggage-carrying loads.
- Provide rapid and reliable transportation between the facility and the airport.
- Coordinate timed transfers and connections of various modes to minimize passenger delays.
- Consider mode-specific planning and design related to operational and enforcement issues (e.g., dispatch and queuing areas for taxis, quick turnaround and maintenance facilities for rental car operations).
- Consider potential passenger perceptions of level of convenience resulting from number of mode transfers and location of the facility in relation to boarding areas.
- Consider availability of funding sources for financing the facility, including both airport and nonairport sources (ISTEA funds, user fees). Identify the need for project support (State and local transportation and transit agencies, commercial vehicle operators, airlines).

Off-Airport Intermodal Facilities

Off-airport intermodal facilities, often referred to as satellite terminals, are typically operated by either public or private agencies, rather than the local airport. These facilities can be classified broadly as limited-service or full-service terminals. Table 6.5-2 provides specific planning and design considerations for off-airport intermodal facilities.

Limited-Service Terminals

This classification generally refers to "Park-n-Fly" facilities that provide parking for airport-bound travelers and convenient transfers to a dedicated airport service (e.g., direct rail or bus service). Some facilities may also offer additional passenger amenities, including waiting areas and some airline ticketing services. The Flyaway Service in Van Nuys, CA is an example of this type of facility. It offers a 24-hour bus service to Los Angeles International Airport, with 15- to 30-minute headways during peak periods. This service is convenient to both passengers and employees of the airport. Figure 6.5-1 illustrates the ridership on the bus service that serves the Van Nuys terminal. Bus service is used mainly by passengers, particularly during the peak vacation months of June, July, and August, when passenger ridership is between 60,000 to 70,000 riders per month. The use of this facility by employees of the airport is relatively constant throughout the year, with approximately 10,000 passengers each month. In addition to bus service, the facility provides 2,000 parking spaces, ticket counters for several airlines, skycap baggage service, waiting areas, and parking lot security for its passengers. (Passengers may purchase bus tickets until 2 minutes before bus departure.)

Another example of this type of facility is the Logan Express bus service, which serves the Boston, MA area.

Full-Service Terminals

These facilities, operating as remote airport passenger terminals, offer ticketing and baggage check in services in addition to transportation to the nearest major airport.

Planning Issues To Be Considered in Designing Off-Airport Intermodal Facilities

Planning for these off-airport intermodal facilities often requires close coordination among various public and private entities, including private commercial vehicle operators, rail and transit agencies, the airport, local communities, and MPOs. When designing an intermodal facility, it is important to ensure a good fit with the remainder of the transportation system and to ensure the transportation system's fit with the intermodal facility. The following issues should be addressed when planning for off-airport intermodal facilities:[41]

- Properly locating a facility relative to other facilities and modes to appropriately attract high passenger levels (e.g., along a congested highway corridor that provides HOV lanes, within a corridor with high levels of airport-bound business trips)

- Relocating modes to better serve the facility

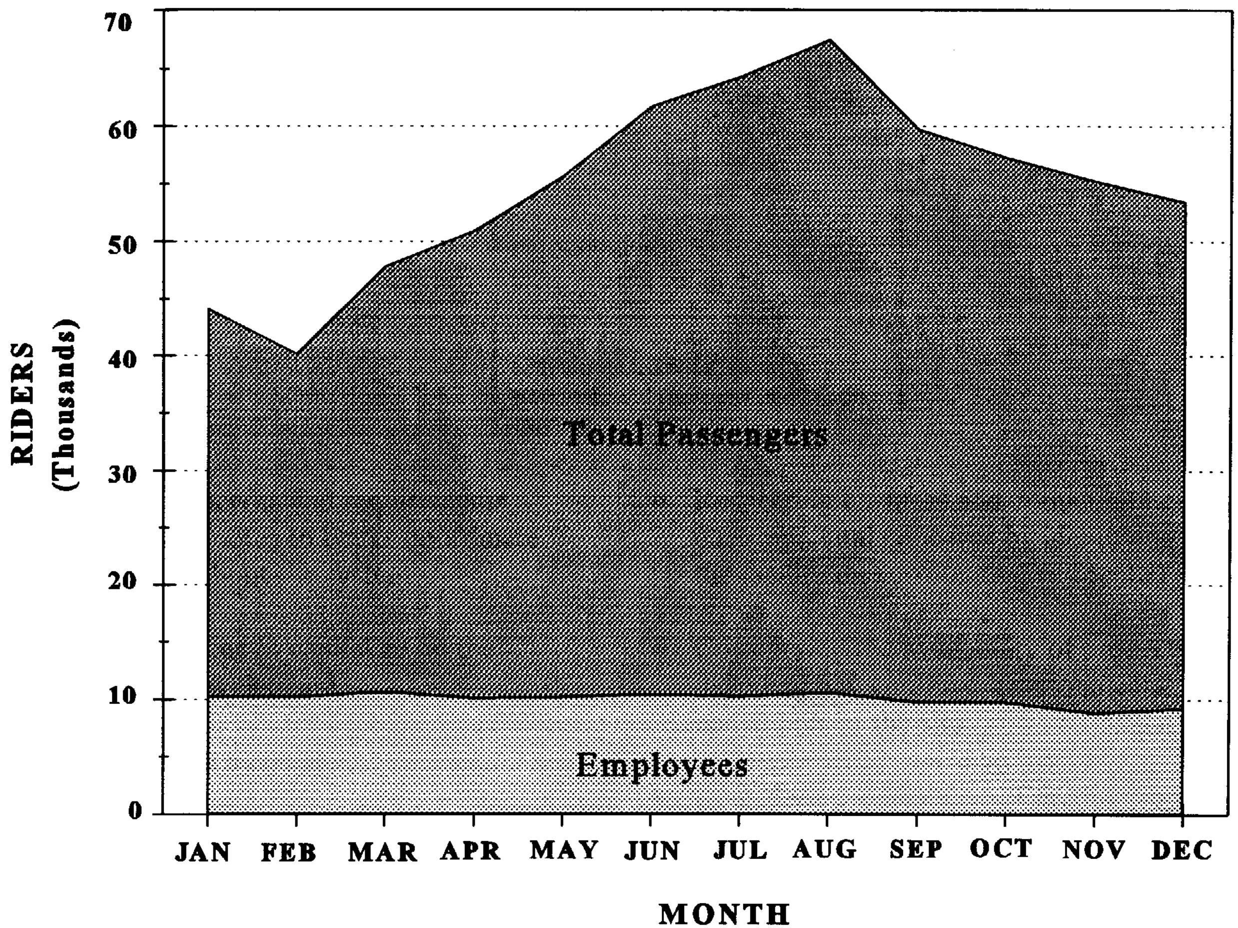

Figure 6.5-1. Van Nuys Express Ridership

Table 6.5-2. Off-Airport Intermodal Transportation Facilities

Type Of Facility	Description	Examples	Planning Issues To Be Considered
Limited-Service Terminals	Satellite terminals, typically operated by public or private agencies other than the local airport. Park n' Fly facilities, providing parking for airport-bound travelers and convenient transfers to dedicated transit service to the airport. Facility may offer additional passenger amenities, including waiting areas and some airline ticketing services.	Flyaway Service in Van Nuys, CA, is a 24-hour bus service to LAX. It provides 2,000 parking spaces, ticket counters for several airlines, skycap baggage service, waiting areas, and parking lot security for passengers.	Coordinate multiple-agency concerns and requirements (i.e., rerouting of public transit services, potential funding sources, etc.). Identify feasible locations for off-airport intermodal facilities that are appropriately located to attract high passenger levels (i.e., along a congested highway corridor that provides HOV lanes, within a corridor with high levels of airport-bound business trips).
Full-Service Terminals	Remote airport passenger terminals, offering airline ticketing and baggage check in services in addition to transportation to nearest airport.	Currently in Orlando, there are plans to construct an intermodal transportation center designed to function as a remote airport terminal with airline ticketing, security screening, and passenger and baggage check in.	Consider availability of property for the facility, including any land- use, environmental, or physical constraints at the site. Identify potential impact of the facility on surrounding residential or commercial areas.

- Coordinating multiple-agency concerns and requirements, such as realigning schedules and routes to better coordinate transfers at the facility and throughout the system

- Introducing new modes and services to capitalize on the new facility and accommodate new demand

- Establishing priorities of access to facilities

- Redefining the roles of existing transfer facilities to eliminate duplication and develop specialization

- Upgrading the condition of modal equipment to match the new facility

- Respecting business and community needs and environmental concerns by identifying potential impact of the facility on surrounding residential and commercial areas

- Considering the availability of property for the facility, including any land-use, environmental, or physical constraints at the site

- Considering availability of funding sources for financing the facility, including both airport and nonairport sources (ISTEA funds, user fees). Identifying the need for project support (State and local transportation and transit agencies, commercial vehicle operators, airlines).

6.6 Transportation Demand Management

As congestion and environmental problems have worsened, TDM has become more and more important as an alternative for solving congestion problems in urban areas. TDM measures are designed to reduce the number of vehicle trips made by shifting trips to higher occupancy modes. As has been discussed elsewhere in this guide, there are two major travel markets that need access to an airport, employees and travelers. These two groups usually do not travel at the same time and often are coming from different areas. Most TDM measures are designed to encourage employees to use higher occupancy vehicles and may be relevant to airport and tenant employees who work at an airport. A limited number of measures are also relevant to air passengers. These measures often complement or supplement other airport access alternatives, such as transit or parking improvements.

Management of Employee Trips

A study of California airports estimated that 40 percent of all vehicle trips to the airport and 20 percent of all airport-related VMT are by employees.[43] A study at Logan Airport in Boston reported that 25 percent of vehicle trips to the airport are by employees.[44] These estimates are probably applicable to airports nationwide; therefore, employees are responsible for a considerable portion of the regional VMT associated with airport operations and an even higher proportion of the congestion occurring on airport access roads.

Employee trip reduction measures have been studied and applied at urban and suburban employment centers for a number of years; however, there is much less experience with measures aimed specifically at airport employees, who are different in many ways from the usual office employees. Many airport activities take place 24 hours a day and are performed by employees who work on different shifts. Many employees begin at least one end of their trips outside normal working hours and often must be at work before public transportation starts to operate. Other employees, such as flight crews, may only travel to and from the airports at their home bases once or twice a week on variable schedules and cannot arrange for ride-sharing. Employees at most U.S. airports enjoy on-airport parking, fully subsidized by their employers. Nonetheless, planners should analyze the employee situation at an airport, understand the different markets, and identify potential applications of TDM measures. The tables in sections 6.6 will provide some information on employee-related TDM measures. Further descriptions of TDM measures and their application to employees can be found in *FHWA TDM Measures.*[45]

Management of Passenger Trips

The implementation of a successful TDM program to reduce airport passenger ground access trips is considerably more difficult than for employee trips. Passengers do not travel to the airport on a regular basis and, therefore, cannot make regular ride-sharing arrangements, such as vanpools and carpools. Passengers can be encouraged to travel in higher occupancy modes through parking pricing policies and through the provision of convenient express transit services, such as the Boston Logan Express service.

Air passengers are concerned about getting to and from the airport as quickly, conveniently, and reliably as possible. They cannot afford to miss their flights and are often on tight schedules. Passengers will only use high-occupancy modes if they are perceived as reliable and fast. Air travelers, particularly those traveling on business, are often not particularly sensitive to the cost of the access trip, including parking charges, and are willing to pay for the convenience of taking taxis or parking at an airport. However, experience with work travelers has shown that, if the cost of driving alone is increased and high-quality alternatives are provided, passengers making business and pleasure trips will be more likely to shift to higher occupancy modes. The willingness of passengers and employees to use higher occupancy modes, if they have the right characteristics, is shown by the ridership on the Logan Express in Boston, the Flyaway service in Los Angeles (as shown in figure 6.5-1), and Metrorail at Washington National Airport.

Estimates of achievable HOV by passengers can be made by analyzing the mode splits that were reported in the tables included in section 6.4. The results of this analysis, included as table 6.6-1, show that high-occupancy use ranges from 37 percent, of passengers originating at Philadelphia International Airport, to 5 percent, of pasengers originating at the airport in Wichita, KS.

Table 6.6-1. HOV Use at Different Size Airports

Originations (Millions)	Number of Airports	Highest HOV Use (Percent)	Lowest HOV Use (Percent)	Median HOV Use (Percent)
>5	11	37	15	24
2.5-5.0	9	33	10	13
1-2.5	1	16	16	--
.5-1.0	2	16	5	--
<.5	1	15	15	--

Management of Commercial Vehicles

Commercial vehicles, such as taxis, limousines, van services, and bus services, can also contribute to airport congestion. These vehicles often circulate through the terminal access roads looking for passengers to pickup, monopolize terminal curb space, or block terminal roads. Management of curbside use by these vehicles is discussed in section 6.3. Other approaches to managing these vehicles, as well as autos that circulate through the terminal area, and locations where management techniques have been implemented are described in table 6.6-2.

Table 6.6-2. Commercial Vehicle Management

TDM Measure	Description	Examples
Vehicle Entrance Fee	All vehicles entering an airport are charged a fee whether they go to the curb or parking lot or just pass through.	Dallas/Fort Worth International Airport charges all vehicles a $0.50 entrance fee
Limits on Taxis and Limousines	Taxis and limousines are required to have entry permits; exclusive contracts and/or trip fees are imposed.	San Francisco, Sacramento, Los Angeles International, and John Wayne
Limits on Hotel, Parking, and Car Rental Shuttles	Using AVI, a circuit fee on shuttles is imposed to encourage picking up as many riders as possible per trip and limiting circulation around the terminal. Consolidate shuttle services (e.g., hotel/model and rental car) by using the same shuttle for multiple locations.	Los Angeles International, Dallas/Ft. Worth, Minneapolis-St. Paul, Washington National

TDM Measures

This section discusses several types of TDM measures that are applicable to airport-related employees, airport passengers, and commercial vehicles that serve airports. The types of TDM measures discussed in this section include:

- HOVs
- Financial incentives
- Parking management
- Information and marketing
- Airport access fees and circulation control.

HOVs

A number of transit options were discussed in section 6.4. These options, such as express and shuttle buses, are traditionally viewed as TDM measures and provide an alternative to SOVs for employees, as well as passengers.

In addition to the transit services described earlier, airport employees can also carpool or vanpool to work. The inflexibility and variety of work schedules make it difficult for many employees to take advantage of traditional carpools and vanpools as an alternative to driving alone. However, employers at an airport can sponsor carpool and vanpool programs for those employees who can take advantage of them. Vanpooling programs encourage groups of employees to ride

Discouraging passengers from driving to the airport and parking in long-term lots does not always reduce congestion and air pollution. Some alternative modes, such as pickup/dropoff and taxis, may actually increase vehicle trips associated with passenger access to the airport. A useful concept for comparing the ground access impact of each mode is the average number of vehicle trips per passenger (VTPP). This measure was developed by Boston Central Transportation Planning Staff, based on information from a 1987 air passenger survey. The higher the VTPP is for a mode, the greater its negative effect on congestion and air pollution. VTPP will be different in different situations. For example, Los Angeles International and San Francisco International airports have experienced much lower occupancies for their door-to-door van services and would probably have a much higher VTPP for that mode.

LOGAN INTERNATIONAL AIRPORT

VTPP by Ground Access Mode[19]

Access Mode	VTPP
Pickup/Dropoff*	**1.29**
Taxi	**1.09**
Long-Term Park	**0.74**
Rental	**0.64**
Door-to-Door	**0.33**
Scheduled HOV**	**0.10**
Transit***	**0.00**

*** Pickup/Dropoff includes short-term parking.**
**** Includes Logan Express.**
***** MBTA Blue Line to Massport shuttle bus and Logan Water Shuttle.**

to work together in a van that is driven by one of the employees. Employers can support vanpooling by:

- Providing ride-matching assistance
- Buying or leasing vans for employees use
- Subsidizing employee ownership or leasing
- Subsidizing vanpools or riders by paying operational expenses and parking costs
- Insuring vans
- Maintaining vans
- Fueling vehicles.

Financial Incentives

Airport employers can provide financial incentives that encourage employees to use higher occupancy modes. Financial incentives that can be provided by employers include ride-share subsidies, transportation allowances, and indirect incentives, as described in table 6.6-3. If employees are provided high-quality service as an alternative to driving alone, these incentives provide further impetus for airport workers to use higher occupancy modes.

Table 6.6-3. Financial Incentives

TDM STtrategies	Characteristics	Examples
Ride-share subsidies	Regular, periodic payments made to employees who use car/vanpools, transit, bicycles, or other alternatives to driving alone. Subsidies most often provided as cash payments of a predetermined amount or as a reimbursement for actual travel costs, but may also include prepaid fare media, such as transit passes or coupons.	Union Bank San Diego, CA: Offers 315 employees 100 percent transit subsidy. Employees have free parking, but off-site, in a company-leased garage several blocks away. Monthly garage pass holders are given passes to downtown trolley service, which connects garage to office.
Transportation and travel allowances	Regular, periodic payments provided either as cash payments or one-time income adjustments. These differ from subsidies in that they are given to all travelers, even those who drive alone. Flexibility in mode choice is provided, because no mode is favored over others.	CH2M HILL, Bellevue, WA: Travel allowance of $40 per month.
Indirect financial incentives	Employers who do not want to offer employees cash payment can provide positive economic incentives to shift drivers to ride-sharing by offering measurable benefits with monetary, but non-cash value. Use of fleet vehicles for ride-sharing; subsidized fuel or maintenance provided on-site or with vouchers accepted at local gas stations; extra vacation time accumulated; catalogue points awarded for ride-sharing and redeemable for merchandise; free or discounted equipment (i.e., walking shoes, bicycles, etc.)	Allergan, Irvine, CA: Offers employees 1 to 2 extra paid vacation days per year for ride-sharing on a regular basis (2 to 3 days or more per week).

Information and Marketing

Another means of encouraging the use of high-occupancy transportation by both airline passengers and employees who work at an airport is to make information on alternative modes easily available to them. This can be accomplished by:

- Ground transportation kiosks at the airport that provide passengers and employees with information
- Transportation coordinators who provide information on request and who actively encourage use of high-occupancy modes
- Programs offering employees who ride-share a guaranteed ride home if they use a high-occupancy mode to reach the airport and cannot use it to go home because of unanticipated work requirements.

These information and marketing measures and other examples are included in table 6.6-4.

Parking Management

Perhaps the most effective TDM measures for airports are parking management measures. Higher charges for parking will encourage employees and some passengers to look for high-quality multipassenger alternatives to the automobile for their trips to the airport. However, there is a risk that higher prices will increase the dropoff of passengers, which may add to airport congestion and air pollution. Examples of parking management measures and their applicability to employees and passengers are shown in table 6.6-5.

Table 6.6-4. Information and Marketing TDM Measures

TDM Strategy	Characteristics	Examples	Market Sesgment			
			Employees	Visitors	Locally Based Residents	Meeters /Greeters
1. Employer Ride-Matching Program	Employer-sponsored ride-matching assists employees by identifying and matching employees who want to use commuting alternatives.	FMC Corporation, Princeton, NJ	X			
2. Information Dissemination	Bulletin boards, flyers distributed to desks, in-house newsletters, promotional events, such as ride-share fairs.	Kiosk at S.F. Int'l; Germantown Share Ride, Germantown, MD: promotional events, mass mailings, newsletters	X	X	X	X
3. Transportation Coordinator	Provides personalized assistance. Offers individual trip-planning assistance, as well as marketing and information functions.	Irvine Spectrum, Irvine, CA: TMA Coordinator	X	X	X	X
4. Special Promotions	Periodic prize drawings, contests, awards for ride-sharing, commuter and bike clubs, and other activities to attract attention and generate excitement about the use of commuting alternatives.	--	X			
5. Guaranteed Ride Home	Commuter guaranteed not to be stranded without transportation in an emergency. Free or subsidized emergency transportation, generally by taxi or rental car for the trip home.	--	X	X	X	X

Table 6.6-5. Parking Management Program

TDM Strategy	Charactristics	Examples	Market Segment				
			Employees	Visitors	Locally Based Residents	Origination-Visitors	Meeters / Greeter s
Preferential Parking for Ride-sharing	Employees who ride-share receive reserved parking spaces near entrance to building. In situations where parking facilities are large, vary in convenience or attractiveness, or are limited, preferential parking can be an effective incentive to ride-share.	Lawrence Livermore Labs, Livermore, CA: Preferential parking.	X				
Parking Prices/Fees	Fee charged for vehicle parking in a garage, lot, or other facility. Can generate revenue that can be used to subsidize transit and other alternative modes. Single fee paid daily by all vehicles entering facility, single fee paid for monthly parking pass, different rates charged for different modes or at different times of day.	Twentieth Century Corp., Warner Center , W. San Fernando, CA: priced parking. Most major airports.	X	X	X	X	X
Parking Supply Reduction	Limit amount of parking available.		X	X	X	X	X

6.7 Intelligent Transportation Systems

Advanced technology is being embraced as an alternative for solving today's transportation problems. Systems that use this advanced technology are called Intelligent Transportation Systems. Intelligent Transportation Systems can be used to support alternative ground access improvements such as curbside management improvements and improved high occupancy vehicle services. Intelligent Transportation Systems help reduce congestion, improve safety, and reduce air pollution associated with airport ground access.

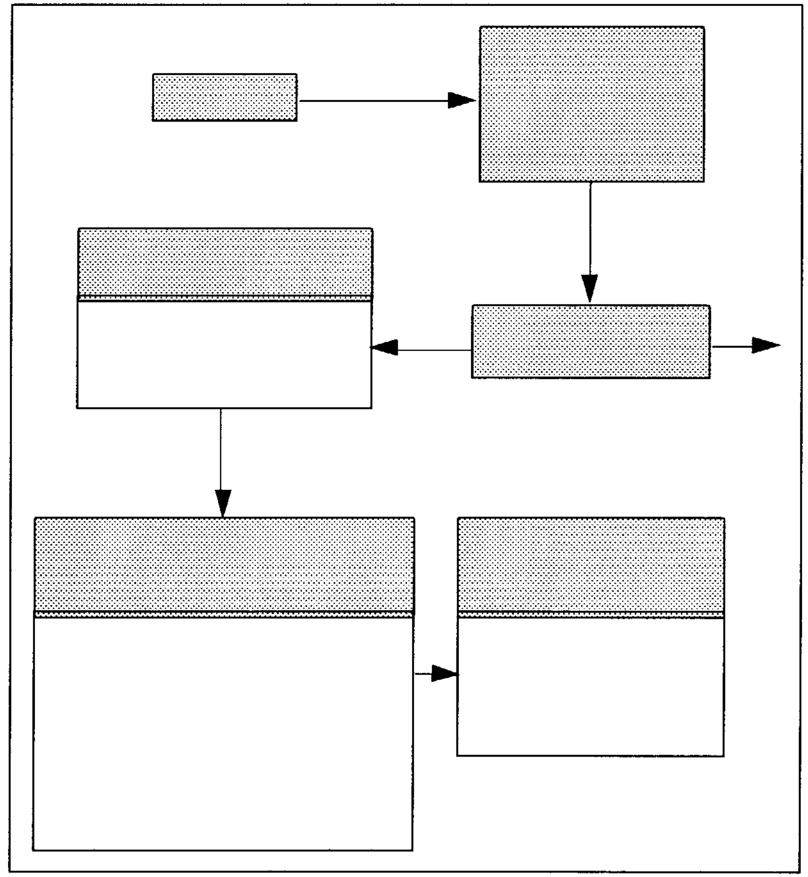

Figure 6.7-1. ITS Implementation Process

Intelligent Transportation Systems Planning Process

Figure 6.7-1 illustrates a process for implementing Intelligent Transportation Systems at airports. After access problems and alternative strategies for solving those problems have been identified, the Intelligent Transportation System (ITS) planning process begins. Intelligent Transportation Systems alone will not solve access problems, but properly chosen and implemented Intelligent Transportation Systems will provide effective support for access management alternatives.

<u>Identify Supportive Intelligent Transportation Systems</u>

After alternative approaches to solving a problem have been identified, ITS capabilities should be reviewed to identify those that could support each alternative.

Table 6.7-1[46] identifies ITS user services that may be employed to support airport ground access. Services such as en-route driver information, route guidance and incident management are currently being used to reduce confusion for airport users when accessing airports. A limited inventory of ITS initiatives currently used at U.S. airports is provided in table 6.7-2[47]. Some airports have different uses for ITS strategies. For example, at BWI, Automatic Vehicle Identification (AVI) will be used to capture the number of trips made by taxis, shuttle buses and other commercial vehicles. At Denver International Airport, AVI is being used to collect revenue information and to control congestion. As illustrated in table 6.7-2, AVI is the predominant ITS strategy being used by airports. Other ITS applications are beginning to be explored, but have not been used to the extent of AVI systems. For example, technologies such as microwave sensors, audio transmissions, and video image processing may someday be used to provide functions similar to those of AVI -- to track and locate commercial ground transportation vehicles, shuttle and taxi dispatch, parking information, and revenue control. Today, in addition to AVI, other ITS initiatives are also being used, such as a traffic information system, which provides information on parking availability at the airport. It is important that the ITS strategies selected for an airport be the best solution for its needs.

This inventory listing and other literature should be evaluated to determine whether ITS can be used to address an airport access problem. One potential problem at an airport is that the curbside is congested during peak hours due to curbside taxi and limousine parking. An alternative for solving that problem is enforcing a maximum dwell time at curbside. This can be supported by an AVI system that identifies vehicles, keeps track of how long they wait at the curbside and charges them for excessive waiting time. Such a system is currently being used at Los Angeles International Airport.

Evaluate Alternative ITS Options

Several alternatives for airport ITS use may be identified. In some cases, one option may support several alternative management strategies while, in other cases, there may be several ITS options for supporting a single strategy. At this point in the planning process, alternative ITS implementations should be evaluated to determine technical feasibility as well as potential costs and benefits. Technical feasibility may be established by examining similar applications at other airports. If the application is unique, it may require a feasibility study. Total life-cycle costs including installation, operation and maintenance costs should be estimated. Benefits may be realized not only by airport passengers, but by airport employees, service providers and in some cases the airlines. The kind of benefits that may derive from ITS include cost savings, reduced travel time, reduced pollution, and reduced capital expenditures for new facilities. These costs and benefits should be analyzed when evaluating alternative airport access improvements within the overall evaluation framework, which is described in Chapter 7.

Table 6.7-1. ITS Services Supportive of Airport Ground Access

General Area	ITS User Services	Functions
Travel and Transportation Management	En-route driver information	Driver advisories and in-vehicle signing for convenience and safety
	Route guidance	Provides travelers with simple instructions on how to best reach destinations
	Traveler services information	Provides a business directory, or "yellow pages", or service information
	Traffic control	Manages movement of traffic on streets and highways
	Incident management	Quickly identifies incidents to generate a response to minimize traffic effects
Travel Demand Management	Pre-trip travel information	Provides information for selecting best transportation mode, departure time, and route
	Ride matching and reservation	Makes ride sharing easier and more convenient
	Demand management and operations	Supports policies and regulations designed to mitigate traffic congestion
Public Transportation Operations	Public transportation management	Automates public transit operations, planning, and management functions
	En-route transit information	Provides schedule and other information to travelers using public transportation after they begin their trips
	Personalized public transit	Supports flexibly routed transit vehicles that offer more convenient service
	Public travel security	Creates a secure environment for public transportation patrons and operators
Electronic Payment	Electronic payment services	Allows travelers to pay for transportation services electronically
Cargo Vehicle Operations	Commercial vehicle electronic clearance	Facilitates domestic and international border clearance, minimizing stops
	Hazardous materials incident response	Provides immediate description of hazardous materials to emergency responders
	Commercial fleet management	Provides communications between drivers, dispatchers, and intermodal transportation providers
Emergency Management	Emergency notification and personal security	Provides immediate notification of an incident and an immediate request for assistance
	Emergency vehicle management	Reduces time it takes emergency vehicles to respond to an incident

Table 6.7-2. ITS Initiatives Being Used at U.S. Airports

ITS Initiative	Project Description	Examples
AVI System	• Collects revenue and fees; • Controls congestion; • Records trip counts for registered ground transportation vehicles; • Tracks commercial vehicles in and out of the airport; • Controls bills, and bills certain groups using accurate circuit counts; • Provides commercial vehicle location, service quality monitoring, access control; • Predicts the amount of time a vehicle spends in the controlled area; • Provides fee assessment, roadway planning, and fee determination; • Controls all commercial traffic within two facilities: the post staging area, and the terminal commercial roadways	Baltimore/Washington, Dallas/Ft. Worth Denver International, Honolulu, Houston John F. Kennedy, Kansas City Los-Angeles/Ontario, Los Angeles International, McCarran, Miami International, Minneapolis/St. Paul Orlando, Philadelphia, Phoenix, Pittsburgh, San Francisco, St. Louis/Lambert
HAR System	Provides parking information from three transmitters on access road to airport	Washington Dulles International
Automated Kiosk	Provides information on ground transportation services, hotel and airport terminal information; maps, etc.	Metropolitan Oakland International, San Jose International, Sacramento, Burbank
Traffic Information System	Provides information on parking availability and road construction in the airport	Washington National

Develop an Architecture to Implement Selected ITS Projects

An architecture is a framework that describes how system components interact and work together to achieve the objectives of the total system (i.e., goals of the selected ITS projects). An architecture is often described graphically with accompanying text. ITS architecture development for airport ground transportation involves several steps. First, the relationship between complementary ITS strategies (e.g., AVI for curbside congestion management and providing parking information at home or on the way to the airport) is determined and then integrated into a general operational framework. Then, the technical and operational requirements of each strategy are determined, such as minimum computer processing speeds for transmitting vehicle identification. Finally, physical elements (e.g., identification hardware, such as an AVI reader) are assigned that would meet the technical and operational requirements of each ITS strategy.

Develop an Implementation Plan

An implementation plan is developed that would rank selected ITS projects based on various criteria, such as user's current needs, political considerations, long and short term airport expansion plan, financial constraints, etc. The implementation plan defines technical and operation guidelines of each strategy. These guidelines would help to clear any operational or regulatory issues such as whether a communication network for AVI would interfere with any airport operations/ communication standards.

ITS deployment can significantly contribute to solving landside access problems. ITS technology can be used for a range of activities, from providing multimodal traveler information to expediting intermodal freight transfer. ITS applications must be considered in the planning process for intermodal ground access to airports. The following should be considered when ITS deployment is considered for an airport.

- Motivation for ITS applications at airports should evolve from user demands.
- On-going ITS and related activities at various airports can act as test beds. The results of these on-going activities should be recorded and analyzed to develop a general access management strategy for airports which can further be modified for a specific airport application.
- ITS is a dynamic concept that is currently in an emerging state. Technologies and user services associated with ITS will change over time with technological innovations.

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Figures

Tables

CHAPTER 7

EVALUATION OF ALTERNATIVES

7.1 Evaluation Process

This chapter provides a general overview of the evaluation phase of the airport ground access planning process. It describes the role and purpose of the evaluation process in terms of highlighting advantages and disadvantages of the alternatives. It also describes the evaluation methods that can be used to rate alternatives. Finally, it discusses tradeoff analysis, in which decisions are made and one alternative is eventually chosen over another. Figure 7.1-1 illustrates the flow of the steps involved in an airport ground access planning process. Evaluation of the alternatives is actually accomplished during the fourth and fifth steps, which lead to the identification of the best alternative in the final step of the process. However, the evaluation process begins during the first step, with the definition of goals, objectives, and performance measures.

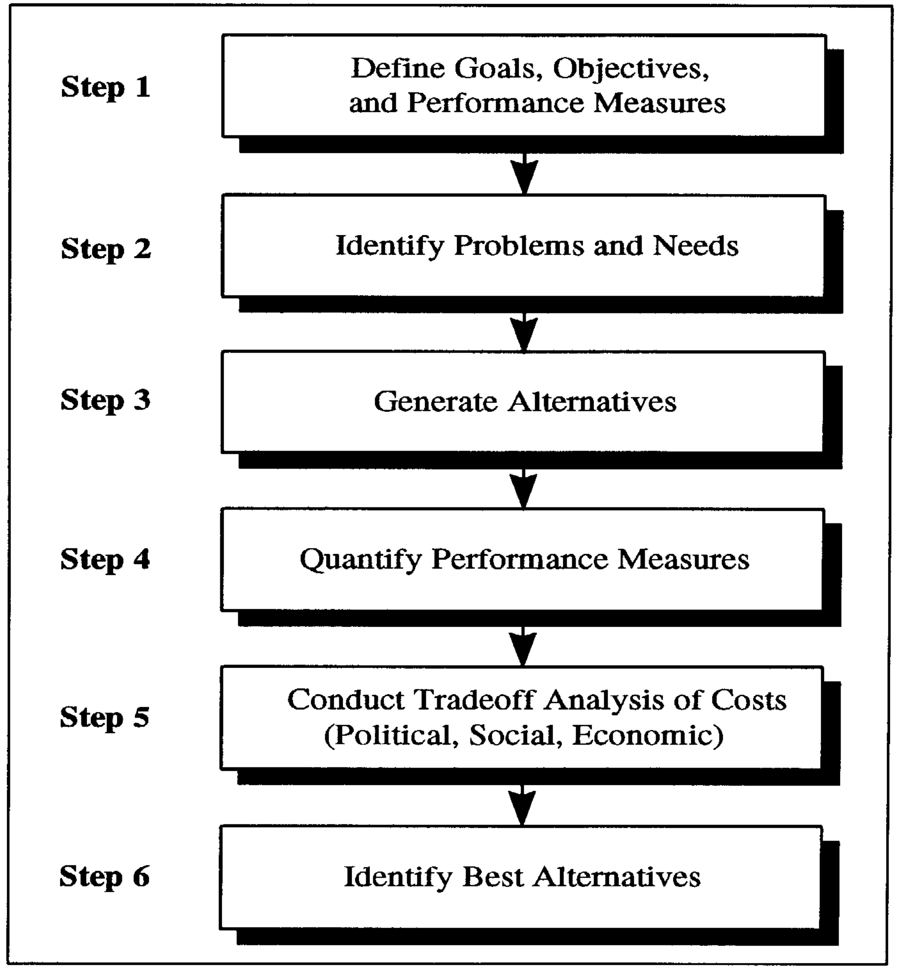


Figure 7.1-1. Airport Ground Access Planning Process

7.2 Evaluation Measures Related to Performance Measures

Given a clear statement of goals and objectives, a key step in the evaluation plan is the identification of performance measures that will be used to determine how well alternatives meet each objective. The use of performance measures to evaluate alternatives was discussed in Chapter 3 of this guide. The evaluation process should be outlined early in a study in an attempt to identify clearly stated goals and objectives and performance measures consistent with those goals and objectives. Performance measures are used to check that desired ends are best served by solutions offered.

The evaluation of alternatives plays a critical role in sifting and organizing information to help highlight the key differences among alternatives. The evaluation process should be able to describe how well each alternative performs with respect to the goals and objectives and should be sufficiently well-structured to identify commonalities, differences, and tradeoffs that exist among the alternatives with respect to the various goals and objectives. The evaluation process is used for comparison of the different study alternatives, comparing costs, benefits, and other effects of each alternative. This phase is a continuous process — with a series of decisions that must be made throughout the analysis that together shape the nature and performance of each alternative. In many ways, evaluation is the central organizing activity throughout the entire project, from the identification in the beginning, to the end analysis. The evaluation criteria provide the basis for continual assessment and refinement of the alternatives as the work progresses and more information becomes available.[1]

The evaluation process involves a synthesis of all benefits, costs, and effects generated by analysis, so that judgments can be made about different alternatives and assessments can be made on the advantages and disadvantages of the alternatives. The evaluation process thus provides important guidance for establishing the rest of the planning process. The evaluation process identifies the type of information that must be produced and the data to be collected by the analysis. This decision process is often characterized by bargaining, consideration of a limited number of alternatives, adjustments to existing situations, and search for consensus to choose the best alternative in terms of cost, benefits, and other considerations.[2,3]

7.3 Evaluation Methodologies

Key methodological issues in determining the value of one alternative over another are: (1) defining how the value is to be measured and (2) estimating the source and timing of the benefits and costs of the proposed actions.[2]

An evaluation process should produce the information needed by participants in the study so that they may make informed decisions. The questions to ask in the evaluation process are basically those that focus on choosing the most appropriate alternative for the problem at hand. These questions tend to be more local in nature and specific to the airport, as opposed to areawide decisions. For example: What ground access problems should receive highest priority? What improvement best fits local goals and objectives? How can the alternatives be funded? What supporting policies should be implemented?[1] Evaluation involves questions related to the effectiveness of alternative projects, efficiency of resource allocation, impact of an equitable distribution of resources, and administrative and legal feasibility of alternative project implementation.[2] Table 7.3-1 shows the issues that are part of the decision-making

Table 7.3-1. Questions That Form the Basis of Alternative Evaluation [2]

Appropriateness	• What information on impact and tradeoffs is required for the decisions that need to be made? • Do the objectives attained by the alternative reflect previously specified community goals and objectives? • What is the distribution of benefits and costs among members of the community (equity consideration)? • Do any groups pay shares of the costs that are disproportionate to the benefits they receive (equity consideration)?
Effectiveness	• Is the alternative likely to produce the desired results? • To what extent are planning and community goals attained through the implementation of the alternative?
Adequacy	• Does the alternative correspond to the scale of the problem and to the level of expectation of problem solution? • Are there other alternatives that might be considered?
Efficiency	• Does the alternative provide sufficient benefits to justify the costs? • In comparison with other alternatives, are the additional benefits provided (or forgone) worth the extra cost (or cost savings)?
Implementation Feasibility	• Will the funds be available to implement the alternative on schedule? • Are there any administrative or legal barriers to alternative implementation? • Does the organizational capability (e.g., staff and expertise) exist to implement the alternative? • Are there groups that are likely to oppose the alternative?
Sensitivity Analysis	• How is the predicted impact modified when analysis assumptions are changed? • What is the likelihood of these changes occurring?

process and that are used as the basis of evaluation efforts. Several characteristics are important to a successful evaluation process, including: relating consequences of alternatives to goals and objectives, analyzing implementation requirements of each alternative, and providing information to decision-makers on the value of alternatives in a readily understandable and useful form and in a timely fashion.

In most planning applications, the evaluation approach first involves the use of sketch-planning techniques that are designed to analyze a large set of alternatives in a short time frame. This leads to the next step, which is to evaluate a small set of the most promising alternatives in greater detail.

There are several methods that can be used in evaluating alternatives. For example, there is a weighting and rating approach, which involves weighting and scoring project attributes to produce a scale measure of project attractiveness. In this method, objectives can be weighted to reflect the preferences of decision-makers and need not be expressed in monetary terms. Problems may arise in that subjective weighting procedures raise questions as to whose values are being applied in the assessment. Also, a rating approach does not indicate whether costs of alternatives are justified by benefits expected.

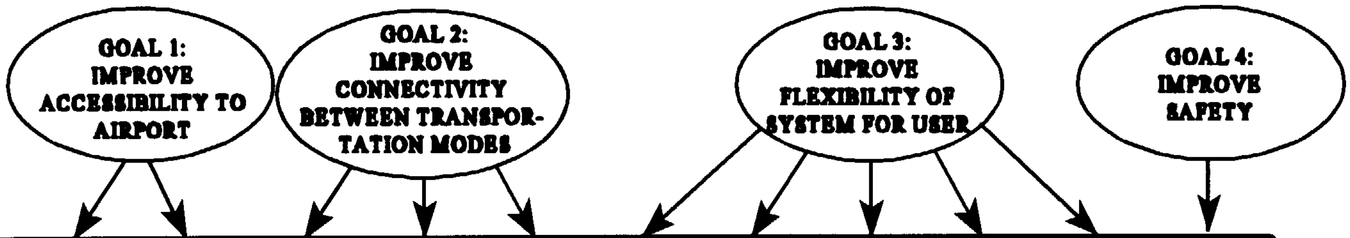
Another method of evaluation is a cost-versus-benefit approach, which involves calculating numerical measures to compare costs with benefits. This becomes a problem when deciding what values to weight and tends to bury the issues in calculations and weightings, which may not be appropriate for all alternatives. A better approach is to use multiple measures of the performance of each alternative.[1]

Two important principles to remember when evaluating, regardless of the method, are: The evaluation measures should provide all information needed to describe the performance of the alternatives with respect to goals and objectives, and the presentation of goals, objectives, and performance measures should be organized in a way that permits coherent analysis of all aspects of all alternatives. The first principle recognizes that the evaluation should be able to describe how well each alternative works with respect to the goals and objectives. The second principle recognizes that the evaluation should identify commonalities, differences, and tradeoffs that exist among the alternatives with respect to the various goals and objectives. Therefore, it is not just one method of measurement that is preferred, but a combination of several methods.

For projects with a larger number of alternatives, it may be useful to organize the evaluation around a smaller number of perspectives that can be used to group related goals together. For example, there are four perspectives that can be used as groupings for evaluating alternatives, as outlined in the *Major Investment Study (MIS) Desk Reference*:

Effectiveness - compares alternatives in terms of how well they address the established problems identified at the outset of the problem-definition stage. In this perspective, it is important that evaluation measures quantify the impact rather than express subjective judgments on the nature of the impact. "Many of the important objectives of an improvement can be difficult to quantify and the consequent temptation is to use subjective evaluation measures: significant or not significant, desirable or not desirable. It is more useful to provide measurements rather than judgements."[1] Although, in terms of a preliminary evaluation assessment, a rating of nonquantifiable may be helpful in lessening the number of alternatives. For example, figure 7.3-1 illustrates this kind of nonquantifiable scale. This way, the alternatives are rated from most effective to least effective with a nonnumerical scaling method. Figure 7.3-2 is another illustration of a rating chart, but this method is more quantifiable in that a numerical rating system is used in which it is easier to identify the better alternatives. The first method is used for a more general analysis, while the second more specifically identifies the more appropriate alternatives, (i.e., the better rated, the better the alternative choice). Effectiveness of an alternative is usually represented as a scaled quantity related to a specific objective (e.g., the number of people having access to transit).[2]

Cost effectiveness - compares alternatives in terms of whether the costs of the project, both operating and capital, are commensurate with its benefits or, in other words, the extent to



OBJECTIVES / ALTERNATIVES	Minimize Travel Time	Provide Peak Capacity	Improve Access & Transfer Between Modes	Connect Major Routes to Local Modes	Improve On-Time Performance at Terminals	Improve Modal Choices for Non-SOV Users	Provide Convenient Transit	Promote Information on Available Services	Provide Frequent HOV Service	Make HOV Services Competitive With Car	Reduce Accidents
ALTERNATIVE 1	Least Effective	Least Effective	Least Effective	Least Effective	Less Effective	Least Effective	Least Effective	Least Effective	Most Effective	Most Effective	Most Effective
ALTERNATIVE 2	Least Effective	Less Effective	Least Effective	Less Effective	Less Effective	Most Effective	Least Effective	Least Effective	Most Effective	Most Effective	Most Effective
ALTERNATIVE 3	Less Effective	Most Effective	More Effective	More Effective	More Effective	More Effective	Least Effective	Least Effective	More Effective	More Effective	Less Effective
ALTERNATIVE 4	Less Effective	Most Effective	More Effective	Most Effective	Most Effective	More Effective	Least Effective	Least Effective	Less Effective	Least Effective	Least Effective

LEGEND

- ● Most Effective
- More Effective
- Less Effective
- Least Effective

Figure 7.3-1. Example of Nonquantifiable Evaluation Method

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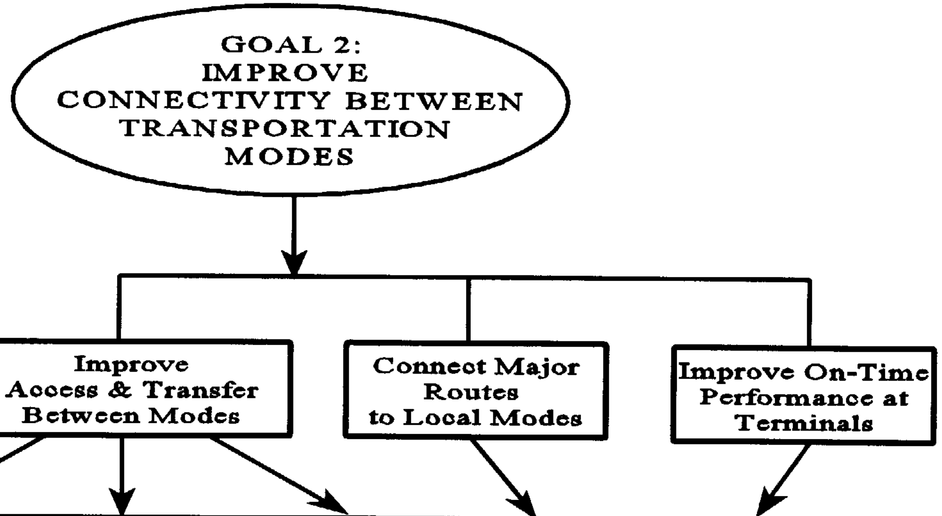

PERFORMANCE MEASURES / ALTERNATIVES	Parking Space Per Passenger	Loading Area Per Passenger (Feet)	Time or Distance of Transfer Between Modes (Minutes)	Layover Times Between Modes (Minutes)	Percent of Surface Transport Departures Outside of 15-Minute Schedule
ALTERNATIVE 1	.6	4	1	3	5
ALTERNATIVE 2	.5	3	4	4	2
ALTERNATIVE 3	.7	2	3	2	4
ALTERNATIVE 4	.4	1	1	2	10

Figure 7.3-2. Example of Quantifiable Evaluation Method

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CHAPTER 8

IMPLEMENTATION

8.1 Funding Sources

Funding Sources for On-Airport Improvements

Continued growth of air traffic has made expansion of the national airport system necessary, because current facilities are inadequate to meet existing and future demands. This expansion requires funding for maintenance and construction of airport infrastructure, including airport terminals, roadways, and transit facilities. Typically, major sources of funding for planning and implementing capital improvements at U.S. airports include:

- Bond financing
- Federal grants via the Airport Improvement Program (AIP)
- Passenger Facility Charges (PFCs).

During the 1980s (before PFCs were available as a funding source), Federal grants for airport development averaged about $1 billion per year, while bond issues averaged more than twice that amount.

Because grants and PFCs do not have to be repaid, they represent the "cheapest" form of capital funding and, for smaller airports that do not have easy access to capital markets, may be the only source of revenue available.[1] States also provide funding for airport capital development; however, the amounts are generally small relative to other sources and vary considerably between States.

Bond Financing

Bond financing at airports is now primarily through revenue bonds that are secured by future airport revenues (and not by the credit and taxing power of the issuing government body). Debt service is paid out of revenues generated by the airport. Airline approval of capital development projects is generally required before an airport issues revenue bonds.

AIP Funding

The AIP is administered by the FAA and was established by the Airport and Airway Improvement Act of 1982. AIP money is available for airport planning and development through the Airport and Airway Trust Fund, which is funded through Federal user taxes on aviation activities, such as a 10 percent domestic passenger ticket tax, air freight tax, and aviation gasoline tax.[2] Historically, the AIP has provided about one-which improvements produce benefits that are commensurate with — or justify — their costs. "The important consideration under this perspective is to determine how to develop appropriate measures of cost-versus-benefits that can be used in conjunction with the various other measures dealing with effectiveness, financial feasibility and equity."[1] It is important to communicate to all participants a reasonable understanding of the tradeoffs between the costs and benefits of each alternative. Virtually all methods of evaluating tradeoffs in costs and benefits focus on the differences between alternatives. The solution, then, is to avoid single measures of tradeoffs between costs and benefits in the evaluation and, instead, focus on careful explanations of the incremental differences.

Financial feasibility - compares alternatives in terms of the availability of funds for construction and operation. Evaluation of alternatives in this perspective involves use of measures of financial feasibility to examine the likelihood that sufficient existing and, where necessary, additional funding sources would be available to cover the capital and operating costs of each alternative. The evaluation of financial feasibility presents measures of the impact of projected funding needs on existing and potential sources of funds.

Equity - compares alternatives in terms of the distribution of costs and benefits among different population groups.

7.4 Tradeoff Analysis

Tradeoff analysis is performed to decide which of the alternatives would best achieve the goals and objectives of the study. The different perspectives discussed in the previous section are used as part of this tradeoff analysis. Tradeoffs may exist among the alternatives in that some may perform well with respect to one goal, while others may perform well for other goals. For example, one alternative may have low capital and operating costs, and produce modest benefits, thereby achieving a high level of cost effectiveness. A second alternative might have significantly higher costs, and much greater benefits, thereby achieving a modest level of cost effectiveness. The tradeoff is whether the first alternative is preferred, because it offers the most efficient use of resources, or the second, because it provides the greatest improvements.

Tradeoff analysis is designed to take the broadest view among the alternatives, highlighting the advantages and disadvantages of each option and pointing out the key tradeoffs of costs and benefits that must be made in choosing a course of action. As discussed in earlier chapters of this guide, the analysis depends on the goals and objectives and the alternatives considered. The major task of tradeoff analysis is to reduce the vast amount of information developed during the analysis of essential differences between alternatives. Its purpose is to frame the decision on a preferred alternative in terms of the advantages and disadvantages of choosing one option compared to the forgone advantages of options not chosen.

1. NTI and Parsons Brinkerhoff Quade & Douglas, Inc. *Desk Reference: National Transit Institute Training Diagram for Major Investment Studies*, Final Review Draft. Washington, DC: FTA, FHWA, 1996.

third of the funding for airport development. From 1982 to 1992, FAA provided approximately $13 billion in AIP grants to help airports improve safety, security, and capacity.[3] These grants may be used for any part of an "airport's landside which encompasses the area from the airport boundary where the general public enters the airport property to the point where the public leaves the terminal building to board the aircraft. Typical eligible landside development items include such things as terminal buildings, entrance roadways and pedestrian walkways."[4]

To obtain an AIP grant for a project, an airport must apply to the FAA. In turn, the FAA must determine that the proposed project meets established AIP eligibility criteria, which are described in the *AIP Handbook*.[4]

As one of the conditions of receiving an AIP grant for capital development, the airport sponsor must provide an assurance that "*all* airport revenues will be expended [only] for the capital or operating costs of the airport . . . [or airport system] . . . directly and substantially related to actual air transportation of passengers or property . . ."[4] (This assurance does not apply to planning projects).

The FAA Authorization Act of 1994 provided a 3-year authorization for the AIP at levels of $2.1 billion for 1994 and about $2.2 billion for both 1995 and 1996. Congress actually appropriated $1.7 billion for 1994 and $1.45 billion for 1995.

In addition to funding projects at airports, AIP appropriations fund certain set-asides for other planning and development activities. For example, the minimum funding level for "integrated airport system planning" in 1995 was 0.75 percent of total AIP funding—a total of about $10 million. After set-asides, AIP funds for development projects at hub airports ($1.1 billion) should equate, on average, to roughly $2.00 per enplaned passenger in 1995.

Major AIP Eligibility Criteria

- With very limited exceptions, project work items must be located within the airport boundary.
- "Roads servicing solely industrial or non-aviation related areas or facilities" are ineligible for AIP funding (this criterion would also apply to rail transit).
- AIP funding of "public parking facilities for passenger automobiles" is specifically prohibited.

PFC Funding

In 1990, the Aviation Safety and Capacity Expansion Act was passed, permitting airports to levy PFCs of up to $3.00 per enplaned passenger to supplement AIP grants. Any public agency controlling a commercial service airport with 2,500 or more enplaned passengers and scheduled service may impose PFCs. No State or political subdivision may prohibit, limit, or regulate the right of the public agency to impose a PFC.[5] The PFC program requires that AIP funds apportioned to a large- or medium-hub airport be reduced if a PFC is imposed at that airport. The reduction takes place in the fiscal year following the approval of authority for PFC collections at that airport and each year the PFC is imposed.[6]

To levy a PFC, a public agency must apply to FAA for approval and use the revenue to finance projects that meet all AIP eligibility criteria and have been approved through the FAA application process.[6] The authority to impose a PFC expires 3 years after the charge date, unless an application has been filed with FAA or an extension of no longer than 2 years has been granted. Additionally, a PFC expires when total PFC revenue plus interest earned equals allowable project costs.[5]

Through the end of 1994, the largest approved uses of PFC funds related to airport access were:

- Over $300 million for an access road and tunnel on McCarran International Airport (Las Vegas)
- $21 million for a feasibility (planning) study of rail service linking Kennedy, LaGuardia, and Newark airports.

Provisions of 1990 Aviation and Safety Capacity Act:

- Total PFCs collected are limited to allowable costs of projects approved in the application.
- PFC funds must be spent at the airport where the PFC is levied (or another airport controlled by the sponsor).
- To qualify for funding, a project must preserve or enhance airport safety, capacity, or security . . . or mitigate noise.
- The Secretary of Transportation decides whether an airport can levy a PFC. Airlines must be consulted, but they have no veto power.

<u>Potential New Sources of Funding</u>

Existing sources of funding are becoming more and more inadequate, thus increasing the need for new sources of additional revenue. Lehman Brothers has proposed the creation of the Aviation Infrastructure Revolving Fund Corporation (AIR Corps), which is an example of an innovative funding scheme. The objective of this scheme is that: "Congress establish an off-budget, federally-chartered Government corporation."[1] The creators of this proposal believe there is a role for a national entity able to leverage the Aviation Trust Fund monies to facilitate access to capital by both public and private sector developers and operators of aviation facilities.

The proposal includes the following functions to be performed by AIR Corps:

- To fund senior and subordinated loans for airport-related facilities

- To provide financial guarantees for taxable and tax-exempt debt issued for airport-related facilities

- To distribute annual capital grants to smaller airports based on an enplanement formula.

AIR Corps could be run as a self-supporting business, receiving revenues from borrower fees, charges, and loan repayments and relending money received from its portfolio of loans to help finance the types of projects currently eligible under the AIP program. Eligible borrowers could be public or private sector owners of airport-related facilities. AIR Corps' obligations would not be guaranteed by the U.S. Government, nor would AIR Corps have a U.S. Treasury line of credit available.

Another mechanism that may potentially provide additional funding opportunities is enhancing the use of PFCs by leveraging them through the use of debt. Some analysts are considering a long-term, standalone bond for an investment-quality rating. Some airports have been able to leverage their PFCs for the length of a revenue bond. This facilitates construction of facilities now with borrowed funds. Debt service on the bond is paid with PFC collections.

Funding Sources for Off-Airport Improvements

In addition to State and local funding sources and direct FAA funding for airports, various Federal revenue sources are available to aid in funding ground access improvements and construction that are considered off-airport improvements. The funding sources that are considered more traditional are illustrated in tables 8.1-1 and 8.1-2. These tables provide information on the different programs, eligible expenditures under each program, the method of apportionment for payment of the funds under each program, and identification of whether the funding may be used for highway, transit, or both types of improvements. Both traditional sources listed, the Federal-Aid Highway and FTA, are Federal programs that may change with new laws. It is important to recognize that the programs in existence now may not be the same in the future; therefore, monitoring the laws to keep abreast of changes to the programs is recommended.

Other, more innovative funding sources, shown in table 8.1-3, require looking beyond the usual sources for ground access funding. These are not necessarily Federal funding sources, but they do provide revenue that may be used for off-airport ground access improvements. Some sources, such as leasing/selling land or facilities, may not work in all jurisdictions, but others, such as sales tax or parking tax, should be acceptable at many airports.

Table 8.1-1. Federal-Aid Highway Funding Sources for Airport Ground Access Improvements

Program	Eligible Expenditure	Method Of Apportionment	Highway/ Transit
Interstate Maintenance (IM)	Resurfacing, restoring, and rehabilitating routes of interstate highway system. Shall not include construction of new travel lanes other than HOV or auxiliary lanes.	To States on basis of interstate system lane miles (55 percent) and interstate system VMT (45 percent).	Highway
National Highway System (NHS)	Projects important to interstate travel and national defense, roads connecting with other transportation modes, and roads essential for international commerce. Funding may also be used for construction of transit projects eligible for assistance under FTA.	Percent share of funds must equal percent share of apportioned funds for FY 87-91 for interstate 4R, primary, secondary, urban and interstate construction; 1/2 percent minimum.	Highway/ transit
Surface Transportation Program (STP)	Block-grant-type program that may be used by States and localities for any roads not classified as local or rural minor collectors. May be any public roads, not just Federal-aid roads. Transit capital projects may be eligible.	Same as NHS. Once funds are distributed, each State must set aside 10 percent for safety and construction activities and 10 percent for transportation enhancements.	Highway/ transit
Congestion Mitigation and Air Quality (CMAQ)	Funding for transportation projects in Clean Air nonattainment areas that contribute toward meeting attainment of national air quality standards. Also eligible, capital cost of transit system expansions/improvements projected to increase ridership.	To States in ratio of weighted nonattainment area population of each State to total weighted nonattainment by all States. If state has none, 1/2 percent minimum allocation guaranteed to each state may be used as STP funds.	Highway/ transit

Table 8.1-2. FTA Funding Source Programs for Airport Ground Access Improvements

Program	Eligible Expenditure	Method Of Apportionment	Highway/ Transit
Section 3 Discretionary and Formula	Capital assistance to eligible transit projects in three categories: construction of new fixed guideway system, modernization of existing rail system, and bus-related construction projects.	Rail modernization funds distributed to urbanized areas with systems in operation at least 7 years on formula basis; new starts and bus funds distributed by discretion of FTA.	Transit
Section 9 Formula Capital and Operating	Funds available on basis of formula to all urbanized areas to finance transit capital and operating expenses.	Six formulas based on urbanized area population and mode of transit service.	Transit
Section 18	Transit capital and operating expenses for rural areas.	5.5 percent of total funds available for Sections 9 and 18. Formula is based on nonurbanized are a population in each state.	Transit

Table 8.1-3. Innovative Funding Sources for Airport Ground Access Improvements

Funding Source	Description	Examples Of Uses For Ground Access Improvements
Local Option Motor Fuel Tax	Taxes on gasoline sales are traditional State revenue sources for highway and transit financing. Some States give their local jurisictions authority to levy local option fuel tax.	A small percentage of the Federal taxes on fuel held in a mass transit account of the highway trust fund. The funding apportioned to States from highway trust fund may be used for highway or transit improvements dealing with airport access.
Sales Tax	Tax levied on purchases of consumer goods and services over and above state and local taxes.	Taxes collected from purchases made at the airport could be used for airport-related improvements.
Tolls	Fees collected for use of facility. Through Section 1012, ISTEA expands eligibility for Federal-aid highway funds for a variety of toll projects, including noninterstate toll highways, bridges, and tunnels.	Tolls can be collected on roads surrounding and leading into and out of an airport. Collections could be used to support ground access improvements. Fees are collected only from users of the system.
Property Tax	Chief source of local revenue. Some cities have succeeded in getting voter approval for a dedicated property tax for transit operations, where a portion of property taxes goes to support transit capital and operating costs.	Property tax, collected from properties in airport vicinity to be used for airport access improvements and construction.
Transit Fares	Fares required from users to ride transit facilities.	Fares collected on facilities serving an airport could be used for transit improvements.
Parking Tax	Imposed on vehicle drivers or facility operators.	Tax collected from on-airport or off-airport parking garage and lot patrons to be used for airport ground access improvements.
Leasing/Selling Land or Facilities	Agencies have potential to generate additional income through leasing or selling all, or portions of, their land holdings or facilities.	Might involve leasing a portion of airport terminal or property to a bus operator, concession stand, or other private enterprise.
Public/Private Agreements — Density Bonus	An agreement by a developer to contribute to transportation improvement in return for additional development rights or considerations.	Developer of projects in and around airport could contribute to improvements of highway and transit in return for some development bonus, such as increased density.

8.2 Setting Project Priorities

After airport ground access problems and solutions are identified, the improvements must be implemented. The resulting airport access improvement program often includes more than one ground access improvement that will contribute to achieving the goals and objectives identified by the airport operator. These improvements often cost more to implement than the airport operating agency has available immediately. In this case the agency must set priorities for implementing the individual elements of the improvement program. This schedule of priorities may be used to determine the order in which improvements are implemented or even if some of the lower priority improvements are ever implemented.

If improvements have been evaluated based on the goals, objectives, and performance measures that are relevant to the needs of the airport and the community, then setting priorities for improvements should be relatively easy. Those improvements that are judged to best meet the objectives are the ones that usually should be implemented first. However, other considerations, such as the availability of funding and unquantifiable community concerns, may need to be considered when deciding the priorities for implementing individual projects.

8.3 Implementation Issues

Political

Airports contribute to the well-being of a community in several ways. First of all, they provide access to a national and international transportation system, linking the community to the Nation and the world. Second, they provide opportunities for employment that are both directly and indirectly related to airport services, in industries that rely on air transportation to deliver their goods and services. Additionally, values of land adjacent to airports are higher because of the proximity to air service.

Along with the advantages of an airport can come disadvantages. For instance, roads and highways providing access to airports can be congested with traffic, because they serve the general needs of the community, as well. In addition, airplanes generate noise and air pollution. This pollution contributes to environmental problems, particularly at airports that are near center city and not on the fringes, such as Boston Logan and Washington National airports. Airports may also compete with the community for municipal services, such as water and power supplies.[7]

A community is interested in making sure that the effects of airport growth are balanced between benefits and costs and that airport growth does not adversely affest the quality of life. If benefits outweigh costs, then the community is satisfied. However, if problems start to outweigh benefits, community activists will try to restrict the airport's ability to grow and expand its services to meet projected demand.

Many times, airports built in what were once remote locations later experience problems from increased suburban growth. For example, Dulles International Airport, near Washington, DC, was built miles from existing development, so that it would not have a negative impact on the surrounding community. Since the airport was built, the area around the airport has become a major suburban residential and commercial center. As the area around Dulles has grown, more issues, such as noise, have been raised by the surrounding community. To limit the ability of the airport to increase its capacity, the community might not support airport ground access improvements. This scenario has been repeated in many localities throughout the United States, as airports stimulate economic development around them. As this happens, local political support for airport improvements decreases, making it more difficult to get support for access improvements.

Community Involvement and Coordination

Community involvement is critical to ensuring that decisions with widespread public impact reflect the public's needs.[8] Involving the community in the airport planning process helps to build political support for airport improvements. If the community participates in setting the goals and objectives for airport access planning efforts and is involved throughout the planning process, a consensus is more likely to be achieved on recommended changes to the ground access system. This consensus will make it easier to implement proposed improvements when the time comes. "Through active citizen participation, citizens are educated to political realities, become more aware of problems, and tend less toward explosive solutions."[9] Conversly, a community ignored throughout the planning process is more likely to stand in the way of the implementation of improvements.

Community involvement programs for airport access planning do not have to be substantially different from those of other transportation studies, such as MISs.[8] Each project is different and, therefore, requires more or less public involvement.

Successful techniques for involving the community in transportation planning are continuously being identified and documented, as illustrated in table 8.3-1. For example, the airport planning organization may wish to establish a focus group, composed of leaders of different stakeholder organizations. This focus group can be consulted throughout the planning process to help ensure that community issues are at least being considered and, it is hoped, adequately addressed. Community meetings and workshops also keep the community informed and help build. Use of the appropriate community involvement techniques will help ensure that appropriate ground access improvements can be implemented.

Environmental Issues

Aircraft noise is often cited as one of the most negative environmental effects of airport improvements and is often the stimulus for community opposition to any airport improvement, including access improvements. Traffic congestion is another impetus to community activism. Often, highways that provide access to airports also provide general access to the rest of the community. Growth of traffic on highways leads to congestion, and both airport and local users suffer. Traffic congestion may also lead to automobile air pollution and perceived safety problems that may lead activists to call for future restrictions, such as on the number of annual passengers permitted to use the airport.

Table 8.3-1. Citizen Involvement Techniques[9]

Technique	Method Of Involvement
Focus Groups	Meetings to obtain feedback from leaders of stakeholder organizations. This is a more targeted audience.
Information and Neighborhood Meetings	Meetings sponsored by an official agency to inform citizens of potential programs and to obtain feedback.
Public Hearings	The traditional, legally required meeting to take formal action on a proposal.
Public Information Programs	Long-term programs providing information by a wide range of methods.
Task Force	An agency-sponsored citizen committee with a specific task and charge relating usually to a single problem or subject.
Citizen Advisory Committee	Citizen groups presumed to represent the ideas and attitudes of local groups; their purpose is to advise the planning agency.
Neighborhood Planning Council	An organization formed by citizens that engages in a number of neighborhood programs, as well as provides advocacy and advice.
Citizen Representation on Public Policy-Making Bodies	Appointing or electing citizens to serve on official city bodies.

If airport access improvements are funded using Federal grants, an EIS or environmental assessment must be prepared by the implementing agency. These environmental studies document the impact of the improvements on wetlands, cultural resources, air quality and other environmental resources. Environmental studies may also be required by local and State regulations.

8.4 Monitoring

After an airport access improvement is implemented, it is usually necessary to determine how well it achieves its original objectives. Does it reduce congestion on airport roadways? Does it encourage more people to go to the airport via a high-occupancy mode? These questions and others regarding the impact of an improvement can usually be answered with data collected using one of the techniques described in Chapter 4 of this guide.

Regular monitoring of the effect of airport access improvements provides the airport operator or local implementing agency with information that will help determine whether further improvements are necessary to meet access needs. Monitoring also helps the planner and operator decide whether an access improvement (e.g., improved van service or roadway changes) should be expanded, or possibly, eliminated. Just like other ground transportation planning, airport access planning is a continuing process that builds on previous projects and plans; therefore, projects should be monitored to facilitate improved planning to meet future demands.

An excellent example of the kind of monitoring process envisioned in the management system regulations can be found in the commitment made by the Massachusetts Port Authority to the Conservation Law Foundation to undertake a program of monitoring and periodic reassessment of its overall ground access strategy. As part of this overall management commitment, the agency has monitored the air quality implications of its actions, ranging from parking pricing policies to the monthly variations in ridership on its express bus services. A series of comprehensive ground access surveys is taken every 5 years, which makes it possible to observe changes in the travel behavior of different market segments of users. This information has made possible the calculation of price elasticities to various services, which allows the examination of various cross-subsidies between modal operations.

1. Lexton, Michael, Managing Director, Lehman Brothers. "Airport Financing Under FAA Restructuring and AIP Re-Engineering (p. 63)," Presented at ACI-NA 1995 Economic Specialty Conference Proceedings: Industry Growth and the Economic Bottom Line. Lexington, KY, April 9-April 12, 1995.

2. U.S. DOT, FAA. *Introduction to the Airport Improvement Program (as Amended in 1987, 1990, 1992)*, Publication FAA-P-5100 (p. 4). Washington, DC: Office of Airport Planning and Programming, FAA.

3. Lacombe, Analynn. "Ground Access to Airports: Prospectus for Intermodalism (p. 389)." *Eno's Transportation Quarterly*. Autumn 1994.

4. U.S. DOT, FAA. *Airport Improvement Program Handbook*, Publication FAA Order 5100.38A. Washington, DC: Office of Airport Planning and Programming, FAA.

5. U.S. DOT, FAA. *Passenger Facility Charges: A Guide for Public Agencies, Air Carriers, Planners and Consultants*, FAA-P-5000-2 (p. 6). Washington, DC: Office of Airport Planning and Programming, FAA, 1991.

6. U.S. DOT, FAA. *Twelfth Annual Report of Accomplishments Under the Airport Improvement Program, Fiscal Year 1993* (p. 9). Washington, DC: FAA.

7. TRB, National Research Council. *Measuring Airport Landside Capacity*, Special Report 215 (p. 45). Washington, DC: TRB, 1987.

8. National Transit Institute. *MIS Desk Reference*. Washington, DC: U.S. DOT, 1996.

9. So, Frank S., Israel Stollman, Frank Beal, and David S. Arnold. *The Practice of Local Government Planning* (p. 555). Washington, DC: International City Management Association, 1979.

APPENDIX A-1
SAMPLE QUESTIONNAIRE FOR COLLECTION SURVEY

XYZ Airport Access Study

XYZ Airport is planning major improvements in its airport terminal, ground transportation and parking facilities. Please take a few minutes to fill out this questionnaire, which will be collected by the stewardess.

About Your Trip

Serial No. ________

A. How did you arrive at XYZ Airport?

1. ☐ By private car - drove myself and parked
2. ☐ By private car - passenger and dropped off curbside
3. ☐ By private car - passenger, and driver also an air passenger
4. ☐ Rental car
5. ☐ Taxi
6. ☐ Door-to-door van
7. ☐ Shared limo (more than one travel party)
8. ☐ Private limo (one travel party)
9. ☐ Bus
10. ☐ Rail
11. ☐ Courtesy vehicle

B. Where did you leave from when you started for the airport today?

Address, City/County, State, Zip

____

____

C. Was this a:

1. ☐ Residence
2. ☐ Hotel/Motel
3. ☐ Work
4. ☐ Other

D. Please indicate your current residence: (if different from B)

Address, City/County, State, Zip

____

____

E. What is the purpose of your trip?

1. ☐ Recreation
2. ☐ Business
3. ☐ Personal / Emergency
4. ☐ Other

F. Did any member of your household, friends, or business associates accompany you to the airport?

☐ Yes ☐ No

How many persons accompanying you actually traveled with you?

Number: _____

G. How many bags did you check for this flight?

Number: _____

H. What is your age?

1. ☐ < 12
2. ☐ 12 - 17
3. ☐ 18 - 25
4. ☐ 26 - 35
5. ☐ 36- 45
6. ☐ 46- 55
7. ☐ 56- 64
8. ☐ + 64

Thank you for your cooperation.

APPENDIX A-2
SAMPLE QUESTIONNAIRE FOR MAILBACK SURVEY

APPENDIX A-3
SAMPLE QUESTIONNAIRE FOR INTERVIEW SURVEY

Date ________________
Time________________

Restaurant ________________
Sightseeing Deck ________________
Souvenir Shop ________________
Drug Store ________________

Serial No. ______________

Respondent 1 2 3 4 5

A. How did you arrive at the airport?
1. By private car - drove myself and parked
2. By private car- passenger and dropped off curbside
3. By private car - passenger, and driver also an air passenger
4. Rental car
5. Taxi
6. Door-to-door van
7. Shared limo (more than one travel party)
8. Private limo (one travel party)
9. Bus
10. Rail
11. Courtesy vehicle

B. Did any member of your household, friends, or business associates accompany you to the airport? Yes/No

How many persons accompanying you actually traveled with you? Number

C. What is the purpose of your trip?
1. Recreation
2. Business
3. Personal/emergency
4. Other

D. Where did you leave from when you started for the airport today? City, State and Zip

Respondent 1 2 3 4 5

D. Where did you leave from when you started for the airport today? City, State and Zip

E. Was this a:
1. Residence
2. Hotel/motel
3. Business
4. Other

F. How many bags did you check for this flight?

G. What is your age?
1. < 12
2. 12 - 17
3. 18 - 25
4. 26 - 35
5. 36 - 45
6. 46 - 55
7. 56 - 64
8. +64

H. Please indicate your current residence. City, State and Zip

APPENDIX A-4
1992 WASHINGTON-BALTIMORE REGIONAL AIR SURVEY (COLLECTION TYPE)

APPENDIX A-5
1992-1993 AIR PASSENGER SURVEY-PORT AUTHORITY OF NEW YORK AND NEW JERSEY (INTERVIEW TYPE)

APPENDIX A-6
1995 ATLANTIC CITY INTERNATIONAL AIRPORT PASSENGER SURVEY

Atlantic City International Airport Access Passenger Survey

ID # (a new increment for each survey)

Sex ❒ male ❒ female
age ❒12-19 ❒ 20-24 ❒ 25-34 ❒ 35-44 ❒ 45-54 ❒ 55-64 ❒65 +

1. Where did you leave from when you started for the airport today?

Atlantic County
Absecon
Atlantic City
W. Atlantic City
Brigantine
Buena
Buena Vista
Corbin
Egg Harbor City
Estelle Manor
Folsom
Galloway
Hamilton
Hammonton
Linwood
Longport
Margate
Mullica
Northfield
Port Republic
Somers Point
Pleasantville
Ventnor
Weymouth
other

Ocean County

Burlington County

Cape May County
Avalon
Cape May City
Cape May Point
Dennis

Middle
North Wildwood
Ocean City
Sea Isle City
Stone Harbor City
Upper
West Cape May
West Wildwood
Wildwood City
Wildwood Crest
Woodbine
other

Salem County
Alloway
Carney's Point
Elmer
Elsinboro
Lower Alloway
Mannington
Oldmans
Penns Grove
Pennsville
Pilesgrove
Pittsgrove Upper Pittsgrove
Quinton Woodstown
Salem other

Cumberland County
Bridgeton Millville
Commercial Shiloh
Deerfield Stow Creek
Downe Upper Deerfield
Lower Fairfield Vineland
Greenwich other
Hopewell
Lawrence
Maurice River

Gloucester County
Franklinville Cross Keys
Star Cross Clayton
Williamstown Cecil
Newfield Victoria
Iona other
Whitman Square
Pitman
Glassboro

Camden County
Winslow
Berlin
Clementon
Atco
Cherry Hill
other

2. Was this a
   a. ❐ Residence
   b. ❐ Hotel/motel (Tony wants identification, I'll note by ID #)
   c. ❐ Casino
      Bally's Park Place
      Caesar's
      Claridge
      The Grand
      Harrah's
      Merv Griffin's Resort
      Sands
      Showboat
      Tropworld
      Trump Castle
      Trump Plaza
      Taj Mahal
   d. ❐ Place of business
   e. ❐ Other

3. What time did you arrive at the airport?
   Hours 1-12 PM in 5 minute increments from 0 to 55
   AM

4. Are you a resident of or visitor to South Jersey?
   a. ❐ Resident
   b. ❐ Visitor
   c. ❐ Other

5. What is your ultimate destination for this flight?
   a. ❐ Bangor, ME
   b. ❐ Manchester, NH
   c. ❐ Providence, RI
   d. ❐ Boston
   e. ❐ Newark
   f. ❐ Albany
   g. ❐ Syracuse
   h. ❐ Philadelphia
   i. ❐ Pittsburgh
   j. ❐ Chicago
   k. ❐ Detroit
   l. ❐ Akron/Canton
   m. ❐ Cleveland
   n. ❐ Ft. Lauderdale
   o. ❐ Key West
   p. ❐ Miami
   q. ❐ Orlando
   r. ❐ Sarasota
   s. ❐ Tampa
   t. ❐ W. Palm Beach
   u. ❐ Atlanta
   v. ❐ Savannah
   w. ❐ Charlotte, NC
   x. ❐ Columbia, SC
   y. ❐ Nashville, TN
   z. ❐New Orleans
   aa. ❐ Phoenix
   bb. ❐ Denver
   cc. ❐ Las Vegas
   dd. ❐ Los Angeles
   ee. ❐ San Francisco
   ff. ❐ Minneapolis/St. Paul
   gg. ❐ Ft. Myers
   hh. ❐ Dallas/ Ft. Worth
   ii. ❐ Houston

6. What is the purpose of today's trip?
   a. ❒ Business
   b. ❒ Recreation
   c. ❒ Combined Business/Recreation
   d. ❒ Personal/Emergency
   e. ❒ Other

7. How many days will you be away on this trip?
   a. ❒ < 1 day
   b. ❒ 1 day
   c. ❒ 2-3 days
   d. ❒ 4-7 days
   e. ❒ 7+ days

8. How did you get to the airport for today's flight?
   a. Private auto NOTE: MULTIPLE ITEMS
      ❒ drove and parked
         Reason for driving alone and parking:
         ❒ free parking
         ❒ no other options for transportation (no bus service)
         ❒ convenient to drive myself at time I want
      ❒ rental
   b. ❒ Private auto-dropped off
   c. ❒ Taxi
   d. ❒ Courtesy Vehicle
   e. ❒ Bus
   f. ❒ Charter Van/Bus
   g. ❒ Limousine
   h. ❒ Other

9. Would you use another mode of transportation to the airport if available, such as:
   a. ❒ An on-call shuttle for a fee from your preferred location.
   b. ❒ A fixed route shuttle for a fee from a nearby location, (not your own).
   c. ❒ A regularly scheduled New Jersey transit bus.
   d. ❒ Would use any of the options
   e. ❒ None
   f. ❒ Don't know

APPENDIX B
1990 BOSTON LOGAN AIRPORT EMPLOYEE SURVEY